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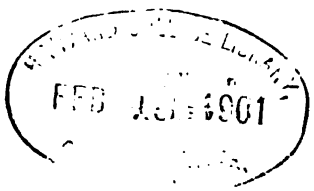

Charles Moore.

Wash. D.C.

CONTENTS.

[Alphabetical index will be found at the end of each part or volume.]

PART I.

OFFICERS OF THE CORPS OF ENGINEERS.

STATUS, changes, and distribution of officers of corps, 3.

THE BOARD OF ENGINEERS 5

BOARD ON TORPEDO SYSTEM..... 5

FORTIFICATIONS.

PROJECTS, 5; gun and mortar batteries, 7; dynamite batteries, range and position finders, 10; preservation and repair of fortifications, supplies for seacoast defenses, sea walls and embankments, 11; sites, submarine mines, 12; defenses of coast of Maine, 13; Portsmouth, N. H., 14; Boston, Mass., 15; southeast coast of Massachusetts and Rhode Island, at New Bedford, Mass., and Newport, R. I., 16; eastern entrance to Long Island Sound and coast of Connecticut, 17; New York City, 19; Delaware River, 20; Baltimore, Md., 21; Washington, D. C., 22; Hampton Roads, Va., coast of North Carolina, 23; coast of South Carolina, 24; coast of Georgia, Cumberland Sound, Ga. and Fla., east coast of Florida, Key West, Fla., 25; Tampa Bay, Fla., Pensacola, Fla., 26; Mobile and Mississippi Sound 27; New Orleans, La., and Sabine Pass, Tex., 28; Galveston, Tex., 29; Great Lakes, 30; San Diego, Cal., 31; San Francisco, Cal., 32; mouth of Columbia River, Puget Sound, 33; estimates for 1901–1902, 35.

EQUIPMENT OF ENGINEER TROOPS AND CIVILIAN ASSISTANTS TO ENGINEER OFFICERS..... 35

POST OF FORT TOTTEN, N. Y.—U. S. ENGINEER SCHOOL.—BATTALION OF ENGINEERS.—ENGINEER DEPOT.

OFFICER IN COMMAND, MAJ. JOHN G. D. KNIGHT, CORPS OF ENGINEERS—

Post of Fort Totten, U. S. Engineer School, Battalion of Engineers, 36; Engineer Depot, statement of funds, 37; new appropriations, estimates, 38.

RIVER AND HARBOR IMPROVEMENTS.

APPROPRIATIONS, emergency river and harbor act, status of works, expenditures, estimates, 39; discontinuance of appropriations and deterioration of works, operating and care of canals, etc., occupancy of piers, wharves, etc., removal of wrecks, establishment of harbor lines, bridges, 40; South Pass of the Mississippi River, construction of hydraulic dredges, 41; Chicago Drainage Canal, 42; Pearl Harbor, Hawaii, memorial bridge and boulevard to connect the capital of the nation with the tomb of Washington, at Mount Vernon, Va., regulations governing the running of loose logs, steamboats, etc., on certain streams, 43; engineer divisions, aid to injured employees, sale of personal property no longer needed, 44.

ATLANTIC COAST AND GULF OF MEXICO.

IN THE CHARGE OF MAJ. S. W. ROESSLER, CORPS OF ENGINEERS—

St. Croix River, Me., 44; Lubec Channel, Me., 45; Moosabec Bar, Me., 46; Narraguagus River, Me., breakwater from Mount Desert to Porcupine Island, Bar Har-

bor, Me., 47; harbor at Sullivan Falls, Me., 48; Union River, Me., 49; Bagaduce River, Me., 51; Penobscot River, Me., 52; Rockland Harbor, Me., 54; Carvers Harbor, Vinalhaven, Me., 56; Georges River, Me., 57; Kennebec River, Me., 58; Portland Harbor, Me., 60; removing sunken vessels or craft obstructing or endangering navigation, 62; examinations and surveys, 63.

IN THE CHARGE OF MAJ. W. L. FISK, CORPS OF ENGINEERS—

Saco River, Me., 64; Cape Porpoise Harbor, Me., 65; Cocheco River, N. H., 66; Exeter River, N. H., 67; harbor of refuge at Little Harbor, N. H., 68; Newburyport Harbor, Mass., 69; Merrimac River, Mass., 70; Powow River, Mass., 71; Essex River, Mass., harbor of refuge, Sandy Bay, Cape Ann, Mass., 72; harbor at Gloucester, Mass., 74; harbor at Manchester, Mass., 75; repair of sea wall at Marblehead, Mass., 76; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 77.

IN THE CHARGE OF COL. CHAS. R. SUTER, CORPS OF ENGINEERS—

Harbor at Lynn, Mass., 78; Mystic and Malden rivers, Mass., 79; Mystic River, Mass., below the mouth of Island End River, 80; harbor at Boston, Mass., 81; Town River, Mass., 85; Weymouth River, Mass., 86; harbor at Scituate, Mass., 88; harbor at Duxbury, Mass., 89; harbor at Plymouth, Mass., 90; harbor at Provincetown, Mass., harbor at Chatham, Mass., 92; removing sunken vessels or craft obstructing or endangering navigation, examinations and survey, 93.

IN THE CHARGE OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS—

Harbor of refuge at Hyannis, Mass., 94; harbor of refuge at Nantucket, Mass., 95; harbor at Vineyard Haven, Mass., 96; Woods Hole Channel, Mass., 97; New Bedford Harbor, Mass., 98; Taunton River, Mass., 99; Sakonnet River, R. I., 100; Sakonnet Point, R. I., Pawtucket River, R. I., 101; Providence River and Narragansett Bay, R. I., 102; removal of Green Jacket Shoal, Providence, R. I., 103; harbor at Wickford, R. I., Fall River Harbor, Mass., 104; Newport Harbor, R. I., 105; harbor of refuge at Point Judith, R. I., 106; entrance to Point Judith Pond, R. I., harbor of refuge at Block Island, R. I., 108; Great Salt Pond, Block Island, R. I., 109; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 110.

IN THE CHARGE OF MAJ. SMITH S. LEACH, CORPS OF ENGINEERS—

Pawcatuck River, R. I. and Conn., 112; harbor of refuge at Stonington, Conn., 114; Mystic River, Conn., 115; Thames River, Conn., 117; Connecticut River below Hartford, Conn., 119; harbor of refuge at Duck Island Harbor, Conn., 122; New Haven Harbor, Conn., 123; breakwaters at New Haven, Conn., 125; Housatonic River, Conn., 126; Bridgeport Harbor, Conn., 129; Saugatuck River and Westport Harbor, Conn., 131; Norwalk Harbor, Conn., 133; Five-mile River Harbor, Conn., 135; Stamford Harbor, Conn., 137; harbor at Coscob and Mianus River, Conn., 138; Greenwich Harbor, Conn., 140; examination and survey, 141.

IN THE CHARGE OF LIEUT. COL. W. H. H. BENYAURD AND MAJS. E. H. RUFFNER AND W. L. MARSHALL, CORPS OF ENGINEERS—

Port Chester Harbor, N. Y., 142; Mamaroneck Harbor, N. Y., 143; Larchmont Harbor, N. Y., 144; East Chester Creek, N. Y., 145; Bronx River, N. Y., 146; Mattituck Harbor, N. Y., 147; Port Jefferson Harbor, N. Y., 148; Huntington Harbor, N. Y., 149; Glencove Harbor, N. Y., 150; Flushing Bay, N. Y., 151; East River, N. Y., 152; Harlem River, N. Y., 153; Newtown Creek, N. Y., 155; Wallabout Channel, N. Y., Canarsie Bay, N. Y., 156; Browns Creek, N. Y., 157; Patchogue River, N. Y., 158; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 159.

IN THE CHARGE OF LIEUT. COL. W. H. H. BENYAURD AND MAJS. H. M. ADAMS AND W. L. MARSHALL, CORPS OF ENGINEERS—

New York Harbor, N. Y., 161; channel in Gowanus Bay: Bay Ridge, Red Hook, and Buttermilk channels, in the harbor of New York, 163; Gowanus Creek Channel, New York Harbor, 165; removing sunken vessels or craft obstructing or endangering navigation, 166; examination of Buttermilk Channel, New York Harbor, 167.

In the charge of Col. J. W. Barlow, Corps of Engineers—

Channel between North and South Hero islands, Lake Champlain, Vt., 167; harbor at Burlington, Vt., 168; Otter Creek, Vt., 169; Narrows of Lake Champlain, N. Y. and Vt., 170; Hudson River, N. Y., 171; Saugerties Harbor, N. Y., 174; harbor at Rondout, N. Y., 175; harbor at Peekskill, N. Y., 176; Passaic River, N. J., 177; channel between Staten Island and New Jersey, 178; Elizabeth River, N. J., Raritan River, N. J., 179; South River, N. J., 180; Raritan Bay, N. J., 181; Matawan Creek, N. J., Keyport Harbor, N. J., 183; Shoal Harbor and Compton Creek, N. J., 184; Shrewsbury River, N. J., 185; Manasquan River, N. J., 186; removing sunken vessels or craft obstructing or endangering navigation, 187; examinations and surveys, 188.

In the charge of Lieut. Col. C. W. Raymond and First Lieut. Spencer Cosby, Corps of Engineers—

Delaware River, N. J. and Pa., 189; harbor between Philadelphia, Pa., and Camden, N. J., Schuylkill River, Pa., 193; ice harbor at Marcushook, Pa., 195; construction of iron pier in Delaware Bay near Lewes, Del., Delaware Breakwater, Del., 196; harbor of refuge, Delaware Bay, Del., 197; Rancocas River, N. J., 198; Cooper Creek, N. J., 199; Mantua Creek, N. J., 201; Alloway Creek, N. J., 203; Goshen Creek, N. J., 204; removing sunken vessels or craft obstructing or endangering navigation, 206; examinations and surveys, 207.

In the charge of Gen. Wm. F. Smith, United States Agent, Major of Engineers, U. S. Army, retired—

Wilmington Harbor, Del., 208; Appoquinimink River, Del, 211; Smyrna River, Del., 212; Muderkill River, Del., 213; Mispillion River, Del., 215; Broadkill Creek, Del., 216; inland waterway from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., 217; Susquehanna River above and below Havre de Grace, Md., Rockhall Harbor and inner harbor at Rockhall, Md., 218; Queenstown Harbor, Md., Chester River, Md., from Crumpton to Jones Landing, 219; Choptank River, Md., 220; La Trappe River, Md., Warwick River, Md., 222; Nanticoke River, Del. and Md., 224; Broad Creek River, Del., 225; Wicomico River, Md., 226; Manokin River, Md., 227; Pocomoke River, Md., 228; removing sunken vessels or craft obstructing or endangering navigation, 229; examinations and surveys, 230.

In the charge of Lieut. Col. O. H. Ernst and First Lieut. Charles W. Kutz, Corps of Engineers—

Patapsco River and channel to Baltimore, Md., 231; channel to Curtis Bay, in Patapsco River, Baltimore Harbor, Md., harbor of southwest Baltimore (Spring Garden), Md., 233; removing sunken vessels or craft obstructing or endangering navigation, 234.

In the charge of Lieut. Col. Chas. J. Allen, Corps of Engineers—

Potomac River at Washington, D. C., 234; Potomac River below Washington, D. C., 238; Occoquan Creek, Va., 239; Nomini Creek, Va., 241; Lower Machodoc Creek, Va., 242; Rappahannock River, Va., 243; Urbana Creek, Va., 245; harbor at Milford Haven, Va., 246; York River, Va., 247; Mattaponi River, Va., 249; Pamunkey River, Va., 250; James River, Va., 251; protection of Jamestown Island, Va., 253; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 254.

In the charge of Majs. James B. Quinn and Thos. L. Casey, Corps of Engineers—

Harbor at Norfolk and its approaches, Va., 255; Western Branch of the Elizabeth River, Va., 256; Nansemond River, Va., 257; Appomattox River, Va., 258; harbor at Cape Charles City, Va., 259; Nandua Creek, Va., 260; waterway from Norfolk, Va., to the sounds of North Carolina, 261; inland water route from Norfolk, Va., to Albemarle Sound, N. C., through Currituck Sound, 262; Edenton Bay, N. C., 263; Roanoke River, N. C., removing sunken vessels or craft obstructing or endangering navigation, 264; examinations and survey, 265.

In the charge of Capt. E. W. Van C. Lucas, Corps of Engineers—

Ocracoke Inlet, N. C., 265; Fishing Creek, N. C., 266; Pamlico and Tar rivers, N. C., 267; Contentnia Creek, N. C., Trent River, N. C., 268; Neuse River, N. C., 269; inland waterway between Newbern and Beaufort, N. C., 270; harbor at Beaufort, N. C., inland waterway between Beaufort Harbor and New River, N. C., 271; New River, N. C., 272; Black River, N. C., Northeast (Cape Fear) River, N. C., 273; Cape Fear River above Wilmington, N. C., Cape Fear River at and below Wilmington, N. C., 274; Town Creek, Brunswick County, N. C., 275; report of Board of Engineers on examination and survey for harbor of refuge at or near Cape Lookout, N. C., examinations, 276.

In the charge of Maj. E. H. Ruffner and Capt. J. C. Sanford, Corps of Engineers—

Waccamaw River, N. C. and S. C., 277; Little Pedee River, S. C., 278; Great Pedee River, S. C., 279; Georgetown Harbor, S. C., 280; Winyah Bay, S. C., 281; Santee River, S. C., 283; Wateree River, S. C., 284; Congaree River, S. C., 285; Congaree River, S. C., from Gervais Street Bridge, Columbia, to Granby, 286; Charleston Harbor, including Mount Pleasant and Sullivan Island shore, S. C., 287; Wappoo Cut, S. C., Beaufort River, S. C., 289; removing sunken vessels or craft obstructing or endangering navigation, 290; examinations and surveys, 291.

In the charge of Capt. Cassius E. Gillette, Corps of Engineers—

Savannah Harbor, Ga., 292; Savannah River, Ga., 294; Savannah River above Augusta, Ga., 296; Doboy Bar, Ga., Darien Harbor, Ga., 297; Altamaha River, Ga., 298; Oconee River, Ga., 299; Ocmulgee River, Ga., 301; Brunswick Harbor, Ga., 302; inside water route between Savannah, Ga., and Fernandina, Fla., 303; Cumberland Sound, Ga. and Fla., 304; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 306.

In the charge of Capts. Thos. H. Rees and C. H. McKinstry, Corps of Engineers—

St. Johns River, Fla., 307; St. Johns River at Orange Mills Flats, Fla., 309; Volusia Bar, Fla., Ocklawaha River, Fla., 310; St. Augustine Harbor, Fla., 311; Indian River, Fla., 312; harbor at Key West, Fla., 314; removing the water hyacinth from Florida waters, dredge for river and harbor improvements in Florida, 315; report of Board of Engineers on examination of Biscayne Bay, Fla., from Miami to the sea, 316.

In the charge of Capts. Thos. H. Rees and Henry Jervey, Corps of Engineers—

Caloosahatchee River, Fla., 316; Charlotte Harbor and Peace Creek, Fla., 317; Sarasota Bay, Fla., 318; Manatee River, Fla., 319; Tampa Bay, Fla., 321; Hillsboro Bay, Fla., 323; Anclote River, Fla., Withlacoochee River, Fla., 324; Suwanee River, Fla., 325; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 326.

In the charge of Capt. C. A. F. Flagler, Corps of Engineers—

Carrabelle Bar and Harbor, Fla., 328; Apalachicola Bay, Fla., 329; Apalachicola River, the Cut-off, and lower Chipola River, Fla., 330; upper Chipola River, Fla., from Mariana to its mouth, 331; Flint River, Ga., 332; Chattahoochee River, Ga. and Ala., 333; Choctawhatchee River, Fla. and Ala., 335; La Grange Bayou, Fla., including Holmes River, Fla., from Vernon to its mouth, 336; harbor at Pensacola, Fla., 337; Blackwater River, Fla. and Ala., 338; Escambia and Conecuh rivers, Fla. and Ala., 339; Alabama River, Ala., 340; Coosa River, Ga. and Ala., 341; operating and care of canals and other works of navigation on Coosa River, Ga. and Ala., examinations and surveys, 343.

In the charge of Maj. Wm. T. Rossell, Corps of Engineers—

Mobile Harbor, Ala., 344; Black Warrior River, Ala., operating and care of locks and dams on Black Warrior River, Ala., Warrior and Tombigbee rivers, Ala., 346; Noxubee River, Miss., Pascagoula River, Miss., 351; Pascagoula River and Horn Island Harbor, Miss., 352; Chickasahay River, Miss., 353; Leaf River, Miss., 354; channel from Gulfport to Ship Island Harbor, Miss., Ship Island Pass, Miss., 355; mouth of Pearl River, Miss., Pearl River, below Rockport, Miss., 356; Pearl River, between Carthage and Jackson, Miss., 357; Pearl River, between Edinburg and Carthage, Miss., Bogue Chitto, La., 358; removing sunken vessels or craft obstructing or endangering navigation, examinations, 359.

IN THE CHARGE OF MAJS. H. M. ADAMS AND JAMES B. QUINN, CORPS OF ENGINEERS—

Inspection of the improvement of the South Pass of the Mississippi River, 360; Chefuncte River and Bogue Falia, La., 361; Tickfaw River and its tributaries, La., 362; Amite River and Bayou Manchac, La., 363; closing crevasse in Pass a Loutre, Mississippi River, improving outlet of the Mississippi River, 365; Bayou Lafourche, La., 367; Bayou Plaquemine, Grand River, and Pigeon bayous, La., 369; Bayou Courtableau, La., 371; Bayou Teche, La., 372; channel, bay, and passes of Bayou Vermilion, La., 373; Mermentau River and tributaries, La., 374; mouth and passes of Calcasieu River, La., 375; Johnsons Bayou, La., removing the water hyacinth, La., 377; mouths of Sabine and Neches rivers, Tex., 378; Sabine River, Tex., 379; harbor at Sabine Pass., Tex, 380; Homochitto River, Miss., 382; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 383.

IN THE CHARGE OF CAPT. C. S. RICHÉ, CORPS OF ENGINEERS—

Galveston Harbor, Tex., 384; deepening the channel from Galveston Harbor to Texas City, Tex., improving Galveston Ship Channel and Buffalo Bayou, Tex., 386; operating and care of Morgan Canal, Tex., Trinity River, Tex., 388; channel in West Galveston Bay, Tex., 389; mouth of Brazos River, Tex., 390; improvement of the Brazos River between Velasco and Richmond, West Galveston Bay Channel, Double Bayou, and the mouths of adjacent streams, 391; Brazos River, Tex., Aransas Pass, Tex., 392; improving harbor at Brazos Santiago, Tex., 393; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 394.

WESTERN RIVERS.

IN THE CHARGE OF MAJS. J. H. WILLARD AND THOS. L. CASEY, CORPS OF ENGINEERS—

Red River, La., Ark., and Ind. T., 398; Red River above Fulton, Ark., Cypress Bayou, Tex. and La., 401; Ouachita and Black rivers, Ark. and La., 402; Bayou Bartholomew, La. and Ark., 404; Bœuf River, La., 405; Tensas River and Bayou Maçon, La., 406; Yazoo River, Miss., 407; mouth of Yazoo River and harbor at Vicksburg, Miss., 408; Tallahatchie River, Miss., 410; Big Sunflower River, Miss., 411; water gauges on the Mississippi River and its principal tributaries, 412; examinations and surveys, 414.

IN THE CHARGE OF CAPT. ROBERT MCGREGOR, CORPS OF ENGINEERS—

Removing obstructions in Arkansas River, Ark. and Kans., 415; Arkansas River, Ark., 416; White River, Ark., 418; Upper White River, Ark., 419; Buffalo Fork of White River, Ark., 420; Cache River, Ark., Black River, Ark. and Mo., 421; Current River, Ark. and Mo., 422; St. Francis River, Ark., 423; removing sunken vessels or craft obstructing or endangering navigation, examinations and surveys, 424.

IN THE CHARGE OF CAPT. EDW. BURR, CORPS OF ENGINEERS—

Removing snags and wrecks from the Mississippi River below the mouth of the Missouri River, 425; Mississippi River, between Ohio and Missouri rivers, 426; harbor at St. Louis, Mo., 428; to prevent the Mississippi River from breaking through into the Cache River at or near Beechridge, above Cairo, Ill., 429; examinations and surveys, 430.

IN THE CHARGE OF MAJ. C. MCD. TOWNSEND, CORPS OF ENGINEERS—

Operating snag boats and dredge boats on Upper Mississippi River, 431; Mississippi River between Missouri River and St. Paul, Minn., 432; operating and care of Des Moines Rapids Canal and Dry Dock, operating and care of Galena River improvement, Ill., La Crosse Harbor, Wis., 433; examinations and survey, 434.

IN THE CHARGE OF MAJ. F. V. ABBOT, CORPS OF ENGINEERS—

Mississippi River between St. Paul and Minneapolis, Minn., 434; construction of reservoirs at head waters of Mississippi River, 435; operating and care of reservoirs at head waters of Mississippi River, Chippewa River, including yellow banks, Wis., St. Croix River, Wis. and Minn., 437; Minnesota River, Minn., 438; Red River of the North, Minn. and N. Dak., 439; improvement of bar at mouth of Warroad River, Minn., 440; gauging Mississippi River at or near St. Paul, Minn., survey of Red Lake and Red Lake River, Minn., 441; survey of Otter Tail Lake and Otter Tail River, Minn., survey of Big Stone Lake and Lake Traverse, Minn. and S. Dak., examinations and surveys, 442.

In the charge of Lieut. Col. Amos Stickney, Corps of Engineers, President of the Missouri River Commission—

Examination and survey of Missouri River at Huntsdale, Mo., and at Napoleon, Mo., 443.

In the charge of Capts. J. C. Sanford and H. M. Chittenden, Corps of Engineers—

Missouri River, between Stubbs Ferry, Mont., and the lower limits of Sioux City, Iowa, 444; improving Upper Missouri River by snagging, Yellowstone River, Mont. and N. Dak., 450; examination of Sioux River, S. Dak., 451.

In the charge of Lieut. Col. M. B. Adams, Corps of Engineers—

Obion River, Tenn., 451; improvement of Forked Deer River, Tenn., 453; Cumberland River, Tenn. and Ky., 454.

In the charge of Maj. Dan C. Kingman, Corps of Engineers—

Tennessee River system, Tennessee River, above Chattanooga, Tenn., 458; below Chattanooga, Tenn., 460; operating and care of Muscle Shoals Canal, Tennessee River, French Broad and Little Pigeon rivers, Tenn., 463; Clinch River, Tenn., 465; Elk River, Tenn. and Ala., 467; examinations and surveys, 468.

In the charge of Maj. Wm. H. Bixby, Corps of Engineers—

Ohio River, 469; operating snag boat on the Ohio River, 472; operating and care of Davis Island Dam, Ohio River, near Pittsburg, Pa., movable dams, Ohio River, 473; survey of Licking River, Ky., examinations and surveys, 476.

In the charge of Maj. Chas. F. Powell, Corps of Engineers—

Monongahela River, W. Va., 477; Monongahela River, Pa., 478; operating and care of locks and dams, Monongahela River, 480; harbor at Pittsburg, Pa., 481; locks and dams at Herr Island, head of Six-mile Island, and at Springdale, Allegheny River, 483; Allegheny River, Pa., 485; survey of West Fork River, W. Va., examination of Youghiogheny River, Pa., 486.

In the charge of Capt. H. F. Hodges, Corps of Engineers—

Muskingum River, Ohio, 487; operating and care of locks and dams on Muskingum River, Ohio, 488; Little Kanawha River, W. Va., 489; operating and care of lock and dam on Little Kanawha River, W. Va., Kanawha River, W. Va., 490; operating and care of locks and dams on Kanawha River, W. Va., 492; Elk River, W. Va., 493; Gauley River, W. Va., 494; Guyandot River, W. Va., 495; Big Sandy River, W. Va. and Ky., 496; operating and care of lock and dam on Big Sandy River, W. Va. and Ky., Tug Fork of Big Sandy River, W. Va. and Ky., 498; Levisa Fork of Big Sandy River, Ky., 499; Kentucky River, Ky., 500; operating and care of locks and dams on Kentucky River, Ky., 502; examinations and survey, 503.

In the charge of Capt. Geo. A. Zinn, Corps of Engineers—

Falls of the Ohio River at Louisville, Ky., operating and care of Louisville and Portland Canal, 506; Wabash River, Ind. and Ill., 507; operating and care of lock and dam at Grand Rapids, Wabash River, 508; White River, Ind., Lock No. 2, Green River at Rumsey, Ky., 509; Green River above the mouth of the Big Barren River, Ky., 510; operating and care of locks and dams on Green and Barren rivers, Ky., Rough River, Ky., 511; operating and care of lock and dam on Rough River, Ky., examinations, 512.

LAKE RIVERS AND HARBORS.

In the charge of Maj. Clinton B. Sears, Corps of Engineers—

Harbor at Grand Marais, Minn., harbor at Agate Bay, Minn., 513; harbor at Duluth, Minn., and Superior, Wis., 514; harbor at Ashland, Wis., 516; harbor at Ontonagon, Mich., waterway across Keweenaw Point from Keweenaw Bay to Lake Superior, Mich., 517; operating and care of waterway across Keweenaw Point from Keweenaw Bay to Lake Superior, Mich., 518; harbor at Marquette, Mich., harbor of refuge, Marquette Bay, Mich., 519; harbor of refuge at Grand Marais, Mich., 520; examinations and survey, 521.

In the charge of Capt. J. G. Warren, Corps of Engineers—

Menominee Harbor, Mich. and Wis., Menominee River, Mich. and Wis., 522; Oconto Harbor, Wis., 523; Green Bay Harbor, Wis., 524; Sturgeon Bay and Lake Michigan Ship Canal, Wis., 525; operating and care of Sturgeon Bay and Lake Michigan Ship Canal, Wis., Sturgeon Bay Canal, harbor of refuge, Wis., 526; Ahnapee Harbor, Wis., 527; Kewaunee Harbor, Wis., Two Rivers Harbor, Wis., 528; Manitowoc Harbor, Wis., 529; Sheboygan Harbor, Wis., 530; Port Washington Harbor, Wis., harbor of refuge, Milwaukee, Wis., 531; Milwaukee Harbor, Wis., 532; South Milwaukee Harbor, Wis., Racine Harbor, Wis., 533; Kenosha Harbor, Wis., 534; Waukegan Harbor, Ill., 535; Fox River, Wis., 536; operating and care of locks and dams on Fox River, Wis., 537; examinations and surveys, 538.

In the charge of Majs. W. L. Marshall and J. H. Willard, Corps of Engineers—

Chicago Harbor, Ill., 540; Chicago River, Ill., 541; Calumet Harbor, Ill., 542; Calumet River, Ill. and Ind., 544; Illinois River, Ill., 545; operating and care of Lagrange and Kampsville locks, Illinois River, and approaches thereto, Illinois and Mississippi Canal, Ill., 546; operating and care of Illinois and Mississippi Canal, canal around lower rapids of Rock River, at Milan, Ill., survey of Upper Illinois and Lower Desplaines rivers, Ill., with view to extend navigation from Illinois River to Lake Michigan, near Chicago, Ill., 549; examination and survey of Chicago River, Ill., examination of Rock River, Ill., 550.

In the charge of Capt. Chester Harding, Corps of Engineers—

Michigan City Harbor, Ind., 550; St. Joseph Harbor, Mich., 552; St. Joseph River, Mich., 553; South Haven Harbor, Mich., 554; Saugatuck Harbor, Mich., 555; Kalamazoo River, Mich., 556; Holland (Black Lake) Harbor, Mich., Grand Haven Harbor, Mich., 557; Grand River, Mich., 558; Muskegon Harbor, Mich., 559; White Lake Harbor, Mich., 560; Pentwater Harbor, Mich., 561; Ludington Harbor, Mich., 562; Manistee Harbor, Mich., 563; harbor of refuge at Portage Lake, Manistee County, Mich., 564; Frankfort Harbor, Mich., 565; Charlevoix Harbor, Mich., 566; Petoskey Harbor, Mich., removing sunken vessels or craft obstructing or endangering navigation, 568; examinations, 569.

In the charge of Lieut. Col. G. J. Lydecker, Corps of Engineers—

Ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, 569; St. Marys River at the falls, Mich., 570; operating and care of St. Marys Falls Canal, Mich., 571; Hay Lake Channel, St. Marys River, Mich., 573; Cheboygan Harbor, Mich., 574; Alpena Harbor (Thunder Bay River), Mich., 575; Saginaw River, Mich., 576; Sebewaing River, Mich., 577; harbor of refuge at Sandbeach, Lake Huron, Mich., 578; mouth of Black River, Mich., 579; Black River at Port Huron, Mich., 580; Pine River, Mich., 581; Belle River, Mich., St. Clair Flats Canal, Mich., 582; operating and care of St. Clair Flats Canal, Mich., Clinton River, Mich., 583; Detroit River, Mich., 584; Rouge River, Mich., 586; examinations and surveys, 587.

In the charge of Col. Jared A. Smith, Corps of Engineers—

Monroe Harbor, Mich, 588; Toledo Harbor, Ohio, 589; Port Clinton Harbor, Ohio, 590; Sandusky Harbor, Ohio, 591; Huron Harbor, Ohio, 593; Black River (Lorain) Harbor, Ohio, 594; Cleveland Harbor, Ohio, 595; Fairport Harbor, Ohio, 598; Ashtabula Harbor, Ohio, 600; Conneaut Harbor, Ohio, 601; removing sunken vessels or craft obstructing or endangering navigation, 603; examinations, 604.

In the charge of Maj. Thomas W. Symons, Corps of Engineers—

Harbor at Erie, Pa., 604; harbor at Dunkirk, N. Y., 605; harbor at Buffalo, N. Y., 606; Buffalo entrance to Erie Basin and Black Rock Harbor, N. Y., 608; Tonawanda Harbor and Niagara River, N. Y., 609; Niagara River from Tonawanda to Port Day, N. Y., 610; examinations and surveys, 611.

In the charge of Maj. Thomas W. Symons and Capt. Graham D. Fitch, Corps of Engineers—

Harbor at Wilson, N. Y., harbor at Charlotte, N. Y., 612; harbor at Pultneyville, N. Y., 613; harbor at Great Sodus Bay, N. Y., harbor at Little Sodus Bay, N. Y., 614; harbor at Oswego, N. Y., 615; harbor at Cape Vincent, N. Y., 616; shoals in the St. Lawrence River between Ogdensburg and the foot of Lake Ontario, 617; harbor at Ogdensburg, N. Y., 618; removing sunken vessels or craft obstructing or endangering navigation, examinations, 619.

PACIFIC COAST.

IN THE CHARGE OF CAPT. JAMES J. MEYLER, CORPS OF ENGINEERS—

San Diego Harbor, Cal., 619; deep-water harbor at San Pedro Bay, Cal., 621, Wilmington Harbor, Cal., 622; San Luis Obispo Harbor, Cal., 623; examinations, 624.

IN THE CHARGE OF LIEUT. COL. WM. H. HEUER, CORPS OF ENGINEERS—

Harbor at Alviso, Cal., 624; harbor at San Francisco, Cal., 625; Oakland Harbor, Cal., 626; San Joaquin River, Cal., Mokelumne River, Cal., 627; Sacramento and Feather rivers, Cal., 628; Sacramento River, Cal., 629; Napa River, Cal., 630; Petaluma Creek, Cal., 631; Humboldt Harbor and Bay, Cal., 632; examinations and surveys, 633.

IN THE CHARGE OF CAPT. WM. W. HARTS, CORPS OF ENGINEERS—

Port Orford Harbor, Oreg., 634; Coquille River, Oreg. (general improvement), 636; Coquille River, Oreg., between Coquille and Myrtle Point, 638; entrance to Coos Bay and Harbor, Oreg., 640; harbor at Coos Bay, Oreg. (dredging), 642; Coos River, Oreg., 644; mouth of Siuslaw River, Oreg., 645; Yaquina Bay, Oreg., 646; Yaquina Bay, Oreg., examination, 649; Tillamook Bay and Bar, Oreg., 650; Upper Columbia and Snake Rivers, Oreg. and Wash., 652; Columbia River at Three-mile Rapids, and construction and equipment of a boat railway from the foot of The Dalles Rapids to head of Celilo Falls, Oreg. and Wash., 655; canal at the Cascades, Columbia River, Oreg., 658; operating and care of canal and locks at the Cascades of the Columbia River, Oreg., Columbia River, between Vancouver, Wash., and mouth of Willamette River, 661; Clearwater River, Idaho, 664; examinations, 665.

IN THE CHARGE OF CAPTS. W. C. LANGFITT AND WM. W. HARTS, CORPS OF ENGINEERS.—

Long Tom River, Oreg., 666; Willamette River above Portland, and Yamhill River, Oreg., 667; Columbia and Lower Willamette rivers below Portland, Oreg., 669; Columbia River, Oreg., below Tongue Point, 670; mouth of Columbia River, Oreg. and Wash., 671; Clatskanie River, Oreg., 672; Lewis River, Wash., 673; Cowlitz River, Wash., 674; gauging waters of Columbia River, Oreg. and Wash., examinations and surveys, 675.

IN THE CHARGE OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS—

Willapa River and Harbor, Wash., 676; Grays Harbor and bar entrance, Wash., 678; Chehalis River, Wash., 680; Puget Sound and its tributary waters, Wash., 681; harbor at Olympia, Wash., 683; waterway connecting Puget Sound with lakes Union and Washington, 684; Everett Harbor, Wash., 686; Swinomish Slough, Wash., 687; Okanogan River, Wash., 689; Pend Oreille River, Wash., 690; Kootenai River, Idaho, between Bonners Ferry and the international boundary line, 691; Flathead River, Mont., examinations and survey, 692.

MISCELLANEOUS.

EXAMINATIONS, SURVEYS, AND CONTINGENCIES OF RIVERS AND HARBORS..... 693

SUPERVISION OF THE HARBOR OF NEW YORK.

LIEUT. COMMANDER JOHN C. FREMONT, U. S. N., SUPERVISOR..... 693

MISSISSIPPI RIVER COMMISSION..... 694

MISSOURI RIVER COMMISSION..... 695

CALIFORNIA DÉBRIS COMMISSION..... 696

BRIDGING NAVIGABLE WATERS OF THE UNITED STATES.

Under authority of special acts of Congress.—(1) Bridges of Escambia County, Ala., across Conecuh River at Hendleys Ferry, near Brewerton, and at Parkers Ferry, (2) bridge of the Rutland-Canadian Railroad Company across Lake Champlain between Alburg, Vt., and Champlain, N. Y., at Rouse Point, (3) bridge of the Union Railroad Company across Monongahela River between Mifflin and Rankin, Pa. (at Carrie Furnaces), (4) bridge of the city of Drayton, N. Dak., across Red River of the

North, (5) bridge of Mr. Frank Hitch across Fishing Creek, N. C., (6) bridge of the city of Cambridge, Mass. (West Boston Bridge), across Charles River between Boston and Cambridge, Mass., (7) bridge of the Ohio Valley Electric Railway Company across Big Sandy River from Kenova, W. Va., to Catlettsburg, Ky., 697; (8) bridge of the Shreveport and Red River Valley Railway Company across Red River at or near Alexandria, La., (9) bridge of the Minnesota and Ontario Bridge Company across Rainy River, Minn., (10) bridge of Tallahatchie County, Miss., across Tallahatchie River near Swan Lake, (11) bridge of the Natchitoches Railway and Construction Company across Red River at Grand Ecore, La., (12) bridge of the St. Charles and St. Louis County Bridge Company across Missouri River at St. Charles, Mo., (13) Cape Nome Transportation, Bridge and Development Company's bridge across Snake River at Nome City, Alaska, 698.

Under authority of State laws.—(1) Bridge of the city of Boston (Chelsea Bridge) across Mystic River between Boston and Chelsea, Mass., (2) bridge of St. Martin Parish, La., across Bayou Teche at Bulliards Cove, 698; (3) bridge of Mr. J. B. Levert across Bayou Teche at St. Johns Plantation, parish of St. Martin, La., (4) bridge of the Highland Park Bridge Company across Allegheny River from a point at or near Highland Park, Pittsburg, Pa., to Sharpsburg, Pa., (5) bridge of King County, Wash., across Snoqualmie River at Novelty, (6) bridge of the city of Milwaukee, Wis., across Kinnickinnic River at Lincoln avenue, (7) bridge of the city of Milwaukee, Wis., across Milwaukee River at Broadway, (8) bridge of the Lake Shore and Michigan Southern Railway Company across Maumee River at Toledo, Ohio, (9) bridge of the Louisville and Nashville Railroad Company across Tensas River near Mobile, Ala., (10) bridge of Wahkiakum County, Wash., across Deep River, (11) bridge of Sacramento County, Cal., across Georgiana Slough at Walnut Grove, (12) bridge of the Kansas City, Shreveport and Gulf Railway Company across Houston River in Calcasieu Parish, La., (13) bridge of the Baltimore and Ohio Railroad Company across Calumet River at South Chicago, Ill., (14) bridge of the Clearwater Short Line Railway Company across Clearwater River near Kamiah, Idaho, (15) bridge of the Ohio and Kentucky Railway Company across the North Fork of Kentucky River; (16) bridge of the Carrollton Electric Railway and Bridge Company across Kentucky River at Carrollton, Ky., 699; (17) bridge of King County, Wash., across Snoqualmie River, near Tolt, (18) bridge of the Charleston Consolidated Railway, Gas and Electric Company (successor to the Charleston and Seashore Railroad Company) across Breach Inlet, S. C., between Sullivan Island and Long Island, (19) bridge of the city of Hoquiam, Wash., across Hoquiam River, (20) bridge of the Bergen County Traction Company across Hackensack River at Hackensack, N. J., (21) bridge of the townships of Springwells and Ecores, Mich., across Rouge River at Fort street, (22) bridge of Mobile County, Ala., across Three-mile Creek, near Mobile, Ala., (23) bridge of the city of New York (bridge No. 3) across East River, N. Y., (24) bridge of the Clearwater Valley Railroad Company across Clearwater River, near the mouth of Lapwai Creek, Idaho, (25) temporary bridge of the city of Boston, Mass., across Mystic River, (26) bridge of the Norfolk Railway and Light Company across Tanners Creek, near Norfolk, Va., (27) bridges of the Guyandot Valley Railway Company across Guyandot River, W. Va., (28) bridge of King County, Wash., across Duwamish River, 700; (29) bridge of the New York Bay Railroad Company across Passaic River, N. J., (30) bridge of the Pittsburg and Lake Erie Railroad Company across the back channel of Ohio River from Fleming Park to head of Neville Island, Pa., (31) bridge of the city of Chicago across the South Branch of Chicago River at Canal street, (32) bridge of the Morris and Essex Railroad Company across Hackensack River, N. J., (33) bridge of the city of Milwaukee, Wis., across Milwaukee River, connecting Grand avenue and Wisconsin street, Milwaukee, (34) bridge of the Pittsburg and Lake Erie Railroad Company across the back channel of Ohio River at the lower end of Neville Island, Pa., (35) bridge of the city of Boston, Mass., across Fort Point Channel (Broadway Bridge), (36) bridge of the city of Chicago, Ill., across Calumet River at Ninety-fifth street, (37) bridge of Burlington County, N. J., across Rancocas Creek at Delanco, (38) bridge of Benton County, Oreg., across Long Tom River at Bundys, (39) bridge of the California and Northern Railway Company across the Eureka Slough, in Humboldt County, Cal., 701.

Alterations.—Bridge of the Chicago and West Michigan Railway Company (Pere Marquette Railroad) across Kalamazoo River at New Richmond, Mich., 702.

BRIDGES OBSTRUCTING NAVIGATION.

(1) Bridge of the Chicago and West Michigan Railway Company across Kalamazoo River at New Richmond, Mich., (2) bridge of the city of New Haven and town of Orange, Conn., across West River at Kimberly avenue, (3) bridge of the Stur-

geon Bay Bridge Company across Sturgeon Bay, Wis., (4) bridge of the townships of Ecorse and Springwells, Mich., across Rouge River at Dix avenue, 702; (4) bridge of the Choctaw, Oklahoma and Gulf Railroad Company across Cache River, Ark., (6) bridge of the Kensington and Tacony Railroad (Pennsylvania Railroad Company) across Frankford Creek, Pa., 703.

BRIDGES AT WASHINGTON, D. C.

IN THE CHARGE OF LIEUT. COL. CHAS. J. ALLEN, CORPS OF ENGINEERS—

Repair of the Aqueduct Bridge across Potomac River, 703; memorial bridge, 704.

MAINTENANCE AND REPAIR OF WASHINGTON AQUEDUCT, INCREASING THE WATER SUPPLY OF WASHINGTON, D. C., INVESTIGATING THE WATER SUPPLY OF WASHINGTON, D. C., AND WASHINGTON AQUEDUCT, D. C., FILTRATION PLANT.

IN THE CHARGE OF LIEUT. COL. A. M. MILLER, CORPS OF ENGINEERS—

Washington Aqueduct, 705; increasing the water supply of Washington, D. C., 707; investigating water supply of Washington, D. C., Washington Aqueduct, District of Columbia, filtration plant, 709.

PUBLIC BUILDINGS AND GROUNDS AND WASHINGTON MONUMENT, DISTRICT OF COLUMBIA.

IN THE CHARGE OF COL. THEO. A. BINGHAM, U. S. ARMY 710

NORTHERN AND NORTHWESTERN LAKES 711

YELLOWSTONE NATIONAL PARK, INCLUDING THE CONSTRUCTION, REPAIR, AND MAINTENANCE OF ROADS AND BRIDGES.

IN THE CHARGE OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS 716

RECONNAISSANCES, EXPLORATIONS, AND WORK IN THE FIELD 718

MAPS 721

MILITARY ROAD FROM FORT WASHAKIE TO MOUTH OF BUFFALO FORK OF SNAKE RIVER, WYO 721

MONUMENT TO SERGT. CHARLES FLOYD.

IN THE CHARGE OF CAPT. J. C. SANFORD, CORPS OF ENGINEERS 722

OFFICERS ON DUTY IN OFFICE OF THE CHIEF OF ENGINEERS .. 723

FORTIFICATIONS, ETC.

APPENDIX No. 1.

REPORT OF THE BOARD OF ENGINEERS 727

APPENDIX No. 2.

REPORT OF THE BOARD ON TORPEDO SYSTEM 731

APPENDIX No. 3.

FORTIFICATIONS, FISCAL YEAR 1899-1900.

(A) COAST OF MAINE. (In the charge of Maj. S. W. Roessler, Corps of Engineers.)—733.

(B) PORTSMOUTH, N. H. (In the charge of Majs. S. W. Roessler and W. L. Fisk, Corps of Engineers.)—768.

(C) Boston Harbor, Mass. (In the charge of Col. C. R. Suter, Corps of Engineers.)—773.
(D) Southeast Coast of Massachusetts and Rhode Island at New Bedford, Mass., and Newport, R. I. (In the charge of Maj. D. W. Lockwood, Corps of Engineers.)—791.
(E) Eastern Entrance to Long Island Sound and Coast of Connecticut. (In the charge of Maj. Smith S. Leach, Corps of Engineers.)—814.
(F) New York, N. Y. (In the charge of Lieut. Col. W. H. H. Benyaurd, Majs. H. M. Adams, W. L. Marshall, and Jno. G. D. Knight, Corps of Engineers.)—827.
(G) Delaware River, N. J., Pa., and Del. (In the charge of Lieut. Col. C. W. Raymond, and Lieut. Spencer Crosby, Corps of Engineers.)—842.
(H) Baltimore, Md. (In the charge of Lieut. Col. O. H. Ernst and Lieut. Charles W. Kutz, Corps of Engineers.)—866.
(I) Washington, D. C. (In the charge of Lieut. Col. Chas. J. Allen, Corps of Engineers.)—876.
(J) Hampton Roads, Va. (In the charge of Majs. Thos. L. Casey and James B. Quinn, Corps of Engineers.)—886.
(K) Coast of North Carolina. (In the charge of Capt. E. W. Van C. Lucas, Corps of Engineers.)—897.
(L) Coast of South Carolina. (In the charge of Maj. E. H. Ruffner and Capt. J. C. Sanford, Corps of Engineers.)—911.
(M) Coast of Georgia and of Cumberland Sound, Ga. and Fla. (In the charge of Capts. Cassius E. Gillette and C. H. McKinstry, Corps of Engineers.)—917.
(N) East Coast of Florida and of Key West, Fla. (In the charge of Capts. C. H. McKinstry and Thos. H. Rees, Corps of Engineers.)—923.
(O) Tampa Bay, Fla. (In the charge of Capts. Henry Jervey and Thos. H. Rees, Corps of Engineers.)—929.
(P) Pensacola, Fla. (In the charge of Capt. C. A. F. Flagler, Corps of Engineers.)—939.
(Q) Mobile and Mississippi Sound. (In the charge of Maj. Wm. T. Rossell, Corps of Engineers.)—943.
(R) New Orleans, La., and Sabine Pass, Tex. (In the charge of Majs. James B. Quinn and H. M. Adams, Corps of Engineers.)—952.
(S) Galveston, Tex. (In the charge of Capt. C. S. Riché, Corps of Engineers.)—958.
(T) Lake Ports. (In the charge of Col. J. W. Barlow, Lieut. Col. G. J. Lydecker, Maj. Thomas W. Symons, and Capt. Graham D. Fitch, Corps of Engineers.)—973.
(U) San Diego, Cal. (In the charge of Capt. James J. Meyler, Corps of Engineers.)—974.
(V) San Francisco, Cal. (In the charge of Lieut. Col. Wm. H. Heuer and Maj. Chas. E. L. B. Davis, Corps of Engineers.)—980.
(W) Mouth of Columbia River, Oreg. and Wash. (In the charge of Capts. W. C. Langfitt and Wm. W. Harts, Corps of Engineers.)—1018.
(X) Puget Sound, Wash. (In the charge of Capt. Harry Taylor, Corps of Engineers.)—1026.

APPENDIX No. 4.

REPORT OF MAJ. JOHN G. D. KNIGHT, CORPS OF ENGINEERS.

Post of Fort Totten, N. Y., 1045; United States Engineer School, 1047; Battalion of Engineers, 1050; Engineer Depot, 1052; equipment of engineer troops, 1059; statement of funds, 1064; new appropriations, estimates, 1067.

PART I.

RIVERS AND HARBORS.

APPENDIX A.

REPORT OF MAJ. S. W. ROESSLER, CORPS OF ENGINEERS.

Improvements.—Lubec Channel, Me., 1074; Moosabec Bar, Me., 1075; Narraguagus River, Me., 1077; breakwater from Mount Desert to Porcupine Island, Bar Harbor, Me., 1079; harbor at Sullivan Falls, Me., 1080; Union River, Me., 1081; Bagaduce

River, Me., 1084; Penobscot River, Me., 1086; harbor at Rockland, Me., 1089; Carvers Harbor, Vinal Haven, Me., 1092; Georges River, Me., 1093; Kennebec River, Me., 1095; Portland Harbor, Me., 1097; removing sunken vessels or craft obstructing or endangering navigation, 1100.

EXAMINATIONS AND SURVEYS.—Penobscot River, Me., at and near Bucksport Narrows, 1101; Bucksport Harbor, Me., 1103; mouth of Kenduskeag River, Me., 1108; Camden Harbor, Me., 1111; Boothbay Harbor, Me., 1117; Kennebec River, Me., between Gardiner and Augusta, 1121; Parkers Head Harbor and Channel, Kennebec River, Me., 1131.

HARBOR LINES.—Rockland Harbor, Me., 1138.

APPENDIX B.

REPORT OF MAJ. W. L. FISK, CORPS OF ENGINEERS.

IMPROVEMENTS.—Saco River, Me., 1143; harbor at Cape Porpoise, Me., 1146; Cocheco River, N. H., 1147; Exeter River, N. H., 1149; harbor of refuge at Little Harbor, N. H., 1151; Newburyport Harbor, Mass., 1153; Merrimac River, Mass., 1155; Powow River, Mass., 1157; Essex River, Mass., 1159; harbor of refuge, Sandy Bay, Cape Ann, Mass., 1161; harbor at Gloucester, Mass., 1164; harbor at Manchester, Mass., 1167; sea wall at Marblehead, Mass., 1168; removing sunken vessels or craft obstructing or endangering navigation, 1169.

EXAMINATIONS AND SURVEYS.—Pull-and-be-damned Point, Portsmouth Harbor, N. H., 1170; Isles of Shoals, Me. and N. H., 1172; piers and breakwater at Rockport, Mass., 1177; Beverly Harbor, Mass., 1182; harbor of refuge, Sandy Bay, Cape Ann, Mass., 1184.

APPENDIX C.

REPORT OF COL. CHAS. R. SUTER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Lynn, Mass., 1189; Mystic and Malden rivers, Mass., 1191; Mystic River, Mass., below the mouth of Island End River, 1193; harbor at Boston, Mass., 1194; Town River, Mass., 1203; Weymouth River, Mass., 1204; harbor at Scituate, Mass., 1206; Duxbury Harbor, Mass., 1209; harbor at Plymouth, Mass., 1210; harbor at Provincetown, Mass., 1214; harbor at Chatham, Mass., 1217; removing sunken vessels or craft obstructing or endangering navigation, 1218.

EXAMINATIONS AND SURVEY.—Winthrop Harbor, Mass., 1219; Cohasset Harbor, Mass., 1221; Sandwich Harbor, Mass., 1224.

HARBOR LINES.—Charles River, at Cambridge, Mass., 1225.

APPENDIX D.

REPORT OF MAJ. D. W. LOCKWOOD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor of refuge at Hyannis, Mass., 1234; harbor of refuge at Nantucket, Mass., 1236; Vineyard Haven Harbor, Mass., 1240; Woods Hole Channel, Mass., 1242; New Bedford Harbor, Mass., 1245; Taunton River, Mass., 1248; Sakonnet River, R. I., 1251; Sakonnet Point Harbor, R. I., 1252; Pawtucket River, R. I., 1254; Providence River and Narragansett Bay, R. I., 1257; Green Jacket Shoal, Providence River, R. I., 1260; Wickford Harbor, R. I., 1261; Fall River Harbor, Mass., 1263; Newport Harbor, R. I., 1265; harbor of refuge at Point Judith, R. I., 1269; entrance to Point Judith Pond, R. I., 1271; harbor of refuge at Block Island, R. I., 1272; Great Salt Pond, Block Island, R. I., 1276; removing sunken vessels or craft obstructing or endangering navigation, 1281.

EXAMINATIONS AND SURVEYS.—Bass River Harbor, Mass., 1282; harbor at Hyannis, Mass., 1284; Cotuit Harbor, Mass., 1287; Vineyard Haven, Mass., for harbor of refuge, 1289; Cottage City, Mass., 1293; New Bedford Harbor, Mass., 1295; Westport Point Harbor, Mass., 1298; channel of Assonet River, Mass., 1300; Pawtucket River, R. I., 1302; Providence Harbor and River, R. I., 1307.

HARBOR LINES.—Mount Hope Bay, at Fall River, Mass., 1311.

APPENDIX E.

REPORT OF MAJ. SMITH S. LEACH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Pawcatuck River, R. I. and Conn., 1320; harbor of refuge at Stonington, Conn., 1322; Mystic River, Conn., 1323; Thames River, Conn., 1325; Con-

necticut River below Hartford, Conn., 1328; harbor of refuge at Duck Island, Conn., 1331; New Haven Harbor, Conn., 1333; breakwaters at New Haven, Conn., 1336; Housatonic River, Conn., 1337; Bridgeport Harbor, Conn., 1339; Saugatuck River and Westport Harbor, Conn., 1342; Norwalk Harbor, Conn., 1344; Five-mile River Harbor, Conn., 1346; Stamford Harbor, Conn., 1347; harbor at Coscob and Mianus River, Conn., 1349; Greenwich Harbor, Conn., 1350.

EXAMINATION AND SURVEY.—Harbor of New London, Conn., 1351; Milford Harbor, Conn., 1356.

HARBOR LINES.—Thames River at New London, Conn., 1363; New Haven Harbor, Conn., 1366; East Branch of Stamford Harbor, Conn., 1368.

APPENDIX F.

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Port Chester Harbor, N. Y., 1378; Mamaroneck Harbor, N. Y., 1381; Larchmont Harbor, N. Y., 1383; East Chester Creek, N. Y., 1387; Bronx River, N. Y., 1389; Mattituck Harbor, N. Y., 1392; Port Jefferson Harbor, N. Y., 1393; Huntington Harbor, N. Y., 1397; Glencove Harbor, N. Y., 1399; Flushing Bay, N. Y., 1401; East River and Hell Gate, N. Y., 1403; Harlem River, N. Y., 1406; Newtown Creek, N. Y., 1411; Wallabout Channel, N. Y., 1413; Canarsie Bay, N. Y., 1415; Browns Creek, Sayville, Long Island, N. Y., 1417; Patchogue River, N. Y., 1419; removing sunken vessels or craft obstructing or endangering navigation, 1421.

EXAMINATIONS AND SURVEYS.—Port Chester Harbor, N. Y., 1422; New Rochelle Harbor and Echo Bay, N. Y., 1423; Westchester Creek, N. Y., 1430; Diamond Reef and Coenties Reef, East River, N. Y., 1435; Bay Shore, Long Island, N. Y., 1441; Patchogue River, N. Y., from Fire Island to Patchogue, 1443; Patchogue River, N. Y., 1446; Sag Harbor, N. Y., 1451; Three-mile Harbor, Long Island, N. Y., 1454.

HARBOR LINES.—East River, N. Y., from Oak Point to Bronx River, 1455; East River, N. Y., from Thirty-seventh street to Thirty-eighth street, 1457.

APPENDIX G.

REPORT OF MAJ. W. L. MARSHALL, CORPS OF ENGINEERS.

IMPROVEMENTS.—New York Harbor, N. Y., 1459; Gowanus Bay Channel, Bay Ridge, Red Hook, and Buttermilk channels, New York Harbor, 1464; Gowanus Creek Channel, N. Y., 1469; removing sunken vessels or craft obstructing or endangering navigation, 1471,

HARBOR LINES.—Jersey Flats, upper New York Bay, opposite Greenville, N. J., 1475.

APPENDIX H.

REPORT OF COL. J. W. BARLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Burlington, Vt., 1482; Otter Creek, Vt., 1484; Narrows of Lake Champlain, N. Y. and Vt., 1485; Hudson River, N. Y., 1487; harbor at Saugerties, N. Y., 1494; harbor at Rondout, N. Y., 1496; harbor at Peekskill, N. Y., 1498; Passaic River, N. J.; 1500; channel between Staten Island and New Jersey, 1502; Elizabeth River, N. J., 1503; Raritan River, N. J., 1504; South River, N. J., 1506; Raritan Bay, N. J., 1508; Matawan Creek, N. J., 1510; harbor at Keyport, N. J., 1511; Shoal Harbor and Compton Creek, N. J., 1512; Shrewsbury River, N. J., 1513; Manasquan (Squan) River, N. J., 1514; removing sunken vessels or craft obstructing or endangering navigation, 1516.

EXAMINATIONS AND SURVEYS.—Saugerties Harbor, N. Y., 1518; Tarrytown Harbor, N. Y., 1520; Arthur Kill, or Staten Island Sound, N. Y. and N. J., 1525; Passaic River, N. J., 1530; Woodbridge Creek, N. J., 1552.

APPENDIX I.

REPORT OF LIEUT. COL. C. W. RAYMOND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Delaware River, N. J. and Pa., 1557; harbor between Philadelphia, Pa., and Camden, N. J., 1566; Schuylkill River, Pa., 1570; ice harbor at Marcus-hook, Pa., iron pier in Delaware Bay, near Lewes, Del., 1574; Delaware Breakwater, Del., 1575; harbor of refuge, Delaware Bay, Del., 1576; Rancocas River,

N. J., 1578; Cooper Creek, N. J., 1580; Mantua Creek, N. J., 1582; Alloway Creek, N. J., 1583; Goshen Creek, N. J., 1585; removing sunken vessels or craft obstructing or endangering navigation, 1587.

EXAMINATIONS AND SURVEYS.—Raccoon Creek, N. J., 1590; Oldmans Creek, N. J., 1598; Maurice River, N. J., 1605; Tuckerton Creek, N. J., 1612; Delaware River, from Philadelphia, Pa., to deep water in Delaware Bay, 1615.

APPENDIX J.

REPORT OF GEN. WM. F. SMITH, UNITED STATES AGENT, MAJOR OF ENGINEERS, UNITED STATES ARMY, RETIRED.

IMPROVEMENTS.—Wilmington Harbor, Del., 1626; Appoquinimink River, Del., 1633; Smyrna River, Del., 1635; Murderkill River, Del., 1637; Mispillion River, Del., 1639; Broadkill Creek, Del., 1641; inland waterway from Chincoteague Bay, Va., to Delaware Bay, at or near Lewes, Del., Susquehanna River above and below Havre de Grace, Md., 1642; Rockhall Harbor and inner harbor, at Rockhall, Md., 1643; Queenstown Harbor, Md., 1644; Chester River, Md., from Crumpton to Jones Landing, 1645; Choptank River, Md., 1646; La Trappe River, Md., 1648; Warwick River, Md., 1650; Nanticoke River, Del. and Md., 1652; Broad Creek, Del., 1653; Wicomico River Md., 1655; Manokin River, Md., 1657; Pocomoke River, Md., below Snow Hill, 1658; removing sunken vessels or craft obstructing or endangering navigation, 1660.

EXAMINATIONS AND SURVEYS.—St. Jones River, Del., 1662; Elk River, Md., 1665; Rockhall Harbor, Md., 1670; Queenstown Harbor, Md., 1673; Claiborne Harbor Md., 1677; Tyaskin (Wetipquin) Creek, Md., 1681; channel to Tangier Island, Tangier Sound, Va., 1684.

APPENDIX K.

REPORT OF LIEUT. COL. O. H. ERNST, CORPS OF ENGINEERS.

IMPROVEMENTS.—Patapsco River and channel to Baltimore, Md., 1687; channel to Curtis Bay, in Patapsco River, Baltimore Harbor, Md., 1692; harbor of Southwest Baltimore (Spring Garden), Md., removing sunken vessels or craft obstructing or endangering navigation, 1693.

HARBOR LINES.—Baltimore Harbor and Patapsco River, Md., 1693; Curtis Bay, Baltimore Harbor, Md., 1697.

APPENDIX L.

REPORT OF LIEUT. COL. CHAS. J. ALLEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Potomac River at Washington, D. C., 1702; Potomac River below Washington, D. C., 1706; Occoquan Creek, Va., 1709; Nomini Creek, Va., 1711; Lower Machodoc Creek, Va., 1714; Rappahannock River, Va., 1715; Urbana Creek, Va., 1717; harbor at Milford Haven, Va., 1719; York River, Va., 1721; Mattaponi River, Va., 1722; Pamunkey River, Va., 1724; James River, Va., 1725; Jamestown Island, Va., 1736; removing sunken vessels or craft obstructing or endangering navigation, 1738.

EXAMINATIONS AND SURVEYS.—Patuxent River, Md., 1739; Breton Bay, Md, 1743; Carters Creek, Va., 1747; Jacksons Creek, Middlesex County, Va., 1753; James River at Richmond, Va., 1754.

HARBOR LINES.—James River at Richmond, Va., 1761.

APPENDIX M.

REPORT OF MAJ. JAMES B. QUINN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Norfolk and its approaches, Va., 1763; Western Branch of Elizabeth River, Va., Nansemond River, Va., 1765; Appomattox River, Va., 1766; harbor at Cape Charles City, Va., 1768; Nandua Creek, Va., 1771; waterway from Norfolk, Va., to the sounds of North Carolina, 1773; inland water route from Norfolk, Va., to Albemarle Sound, N. C., through Currituck Sound, 1778; Edenton Bay, N. C., 1780; Roanoke River, N. C., 1782; removing sunken vessels or craft obstructing or endangering navigation, 1783.

EXAMINATION AND SURVEY.—Middle Ground Bar, Hampton Roads, Va., 1785.

HARBOR LINES.—Elizabeth River, at Norfolk, Va., 1791.

PART III.

APPENDIX N.

REPORT OF CAPT. E. W. VAN C. LUCAS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ocracoke Inlet, N. C., 1793; Fishing Creek, N. C., 1796; Pamlico and Tar rivers, N. C., 1798; Contentnia Creek, N. C., 1801; Trent River, N. C., 1802; Neuse River, N. C., 1804; inland waterway between Newbern and Beaufort, N. C., 1806; harbor at Beaufort, N. C., 1808; inland waterway between Beaufort Harbor and New River, N. C., 1810; New River, N. C., 1812; Black River, N. C., 1813; Northeast (Cape Fear) River, N. C., 1815; Cape Fear River, N. C., above Wilmington, 1816; Cape Fear River, N. C., at and below Wilmington, 1818; Town Creek, Brunswick County, N. C., 1827.
EXAMINATIONS AND SURVEY.—Harbor of refuge, Cape Lookout, N. C., 1829.
HARBOR LINES.—Trent and Neuse rivers at Newbern, N. C., 1837.

APPENDIX O.

REPORT OF CAPT. J. C. SANDFORD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Waccamaw River, N. C. and S. C., 1841; Little Pedee River, S. C., 1845; Great Pedee River, S. C., 1847; Georgetown Harbor, S. C., 1850; Winyah Bay, S. C., 1851; Santee River, S. C., 1856; Wateree River, S. C., 1860; Congaree River, S. C., 1863; Congaree River, S. C., from Gervais Street Bridge, Columbia, to Granby, 1864; harbor at Charleston, including Sullivans Island and Mount Pleasant Shore, S. C., 1867; Wappoo Cut, S. C., 1872; Beaufort River, S. C., 1873; removing sunken vessels or craft obstructing or endangering navigation, 1875.
EXAMINATIONS AND SURVEYS.—Lynchs River, S. C., 1876; Sampit River, S. C., 1883; Estherville-Minim Creek Canal to Alligator River, S. C., 1894; Wee Tee Lake, Williamsburg County, S. C., 1903; waterways between Charleston Harbor and Alligator Creek, S. C., 1908.

APPENDIX P.

REPORT OF CAPT. CASSIUS E. GILLETTE, CORPS OF ENGINEERS.

IMPROVEMENTS.—Savannah Harbor, Ga., 1913; Savannah River, Ga., 1928; Savannah River above Augusta, Ga., 1930; Doboy Bar, Ga., 1933; Darien Harbor, Ga., 1935; Altamaha River, Ga., 1939; Oconee River, Ga., 1942; Ocmulgee River, Ga., 1944; Brunswick Harbor, Ga., 1948; inside water route between Savannah, Ga., and Fernandina, Fla., 1953; Cumberland Sound, Ga. and Fla., 1956; removing sunken vessels or craft obstructing or endangering navigation, 1961.
EXAMINATION AND SURVEY.—Brunswick, Ga., inner harbor, 1962.

APPENDIX Q.

REPORT OF CAPT. C. H. McKINSTRY, CORPS OF ENGINEERS.

IMPROVEMENTS.—St. Johns River, Fla., 1967; St. Johns River at Orange Mills Flats, Fla., 1972; Volusia Bar, Fla., 1978; Ocklawaha River, Fla., 1980; St. Augustine Harbor, Fla., 1981; Indian River, Fla., 1982; harbor at Key West, Fla., and entrance thereto, 1983; removing the water hyacinth from Florida waters, dredge for river and harbor improvements, Fla., 1985.
EXAMINATION.—Biscayne Bay, Fla., from Miami to the sea, via Norris Cut, Bears Cut, and Cape Florida Entrance, respectively, 1986.

APPENDIX R.

REPORT OF CAPT. THOS. H. REES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Caloosahatchee River, Fla., 2015; Charlotte Harbor and Peace Creek, Fla., 2017; Sarasota Bay, Fla., 2018; Manatee River, Fla., 2020; Tampa Bay, Fla., 2022; Hillsboro Bay, Fla., 2025; Anclote River, Fla., 2028; Withlacoochee River, Fla., 2029; Suwanee River, Fla., 2030; removing sunken vessels or craft obstructing or endangering navigation, 2032.
EXAMINATIONS AND SURVEYS.—Orange River, Fla., to the Caloosahatchee, thence to the Gulf, 2032; inside passage from Punta Rasa to Charlotte Harbor, Fla., 2041; Boca Grande and Charlotte Harbor, Fla., 2048; inside passage through Sarasota Bay to Lemon Bay, Fla., 2054; Bay at Hudson, Pasco County, Fla, 2166; Crystal River, Fla., 2074.
HARBOR LINES.—Hillsboro River at Tampa, Fla., 2084.

APPENDIX S.

REPORT OF CAPT. C. A. F. FLAGLER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Carrabelle Bar and Harbor, Fla., 2088; Apalachicola Bay, Fla., 2091; Apalachicola River, the Cut-off, and lower Chipola River, Fla., 2095; upper Chipola River, Fla., from Marianna to its mouth, 2099; Flint River, Ga., 2101; Chattahoochee River, Ga. and Ala., 2106; Choctawhatchee River, Fla. and Ala., 2112; Lagrange Bayou, Fla., including Holmes River from Vernon to its mouth, 2116; Pensacola Harbor, Fla., 2118; Blackwater River, Fla., 2126; Escambia and Conecuh rivers, Fla. and Ala., 2129; Alabama River, Ala., 2132; Coosa River, Ga. and Ala., 2137; operating and care of canals and other works of navigation on Coosa River, Ga. and Ala., 2145.

EXAMINATIONS AND SURVEYS.—Ocklockonnee River, Fla., 2146; East Pass at entrance to Carrabelle Harbor, Fla., 2152.

HARBOR LINES.—St. Georges Sound at Dog Island, Fla., 2158.

APPENDIX T.

REPORT OF MAJ. WM. T. ROSSELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Mobile, Ala., 2161; Black Warrior River, Ala., from Tuscaloosa to Daniels Creek, 2167; operating and care of locks and dams on Black Warrior River, Ala., 2171; Warrior and Tombigbee rivers, Ala. and Miss., 2177; Noxubee River, Miss, 2208; Pascagoula River Miss., 2209; Pascagoula River and Horn Island Harbor, Miss., 2211; Chickasahay River, Miss., 2213; Leaf River, Miss., 2215; channel from Gulfport to Ship Island Harbor, Miss., Ship Island Pass, Miss., 2216; Pearl River at mouth, Miss., 2217; Pearl River below Jackson, Miss., 2218; Pearl River between Carthage and Jackson, Miss., 2220; Pearl River between Edinburg and Carthage, Miss., 2221; Bogue Chitto, La., 2222; removing sunken vessels or craft obstructing or endangering navigation, 2223.

APPENDIX U.

REPORT OF MAJ. H. M. ADAMS, CORPS OF ENGINEERS.

INSPECTION of the improvement of the South Pass of the Mississippi River, 2225.

APPENDIX V.

REPORT OF MAJ. H. M. ADAMS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chefunte River and Bogue Falia, La., 2240; Tickfaw River and its tributaries, La., 2241; Amite River and Bayou Manchac, La., 2243; closing crevasse in Pass a Loutre, Mississippi River, 2245; outlet of the Mississippi River, 2246; bayou Lafourche, La., 2249; Bayou Plaquemine, Grand River, and Pigeon bayous, La., 2251; Bayou Courtableau, La., 2259; Bayou Teche, La., 2260; channel, bay, and passes of Bayou Vermilion, La., 2262; Mermentau River and tributaries, La., 2264; mouth and passes of Calcasieu River, La., 2266; Johnsons Bayou, La., 2268; removing water hyacinths from Louisiana waters, 2270; mouths of Sabine and Neches rivers, Tex., 2272; Sabine River, Tex., 2274; harbor at Sabine Pass, Tex., 2276; Homochitto River, Miss., 2280; removing sunken vessels or craft obstructing or endangering navigation, 2282.

EXAMINATIONS AND SURVEYS.—Atchafalaya Bay, La., 2282; Southwest Pass, Mississippi River, 2287; channel through Sabine Lake, Tex. and La., 2302.

PART IV.

APPENDIX W.

REPORT OF CAPT. C. S. RICHÉ, CORPS OF ENGINEERS.

IMPROVEMENTS.—Galveston Harbor, Tex., 2308; ship channel in Galveston Bay, Tex., 2325; channel from Galveston Harbor to Texas City, Tex., 2326; Galveston Ship Channel and Buffalo Bayou, Tex., 2327; operating and care of Morgans Canal, Tex., 2328; Trinity River, Tex., 2329; Buffalo Bayou, Tex., 2330; channel in West Galveston Bay, Tex., 2331; mouth of Brazos River, Tex., 2332; Brazos River between Velasco and Richmond, West Galveston Bay Channel, Double Bayou, and the mouths of the adjacent streams, Tex., 2334; Brazos River, Tex., 2335; Aransas

Pass, Tex., 2336; harbor at Brazos Santiago, Tex., 2340; removing sunken vessels or craft obstructing or endangering navigation, 2341.
EXAMINATIONS AND SURVEYS.—Turtle Bayou, Tex., 2342; Trinity River, Tex., 2348; East Bay Bayou, Tex., 2379; Clear Creek, Tex., 2385; Dickinson Bayou, Tex., 2396; Chocolate Bayou, Tex., 2403; Highland Bayou, Tex., 2410; Bastrop Bayou, Tex., 2414; Oyster Creek, Tex., 2418; mouth of Brazos River, Tex., 2426; San Bernard River, Tex., 2438; Caney Creek, Tex., 2453; Colorado River, Tex., from mouth to foot of great raft, 2458; canal around the raft in Colorado River, in Matagorda County, Tex., 2461; harbor at Alligator Head, Matagorda Bay, Tex., 2462; harbor at Brazos, Santiago, Tex., 2469.
HARBOR LINES.—Galveston Harbor, Tex., at Fort San Jacinto, 2475; San Jacinto Bay at Laporte, Tex., 2476.

APPENDIX X.

REPORT OF MAJ. THOS. L. CASEY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Red River, La., Ark., and Ind. Ter., 2480; Cypress Bayou, Tex. and La., 2502; Ouachita and Black rivers, Ark and La., 2503; Bayou Bartholomew, La. and Ark., 2513; Bœuf River, La., 2515; Tensas River and Bayou Maçon, La., 2517; Yazoo River, Miss., 2519; mouth of Yazoo River and harbor at Vicksburg, Miss., 2524; Tallahatchie River, Miss., 2534; Big Sunflower River, Miss., 2537; water ganges on Mississippi River and its principal tributaries, 2540.
EXAMINATIONS AND SURVEYS.—Ouachita and Black rivers, Ark. and La., 2544; Red River, Tex., 2565; Alexandria Harbor, La., 2569.

APPENDIX Y.

REPORT OF CAPT. ROBERT McGREGOR, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing obstructions in Arkansas River, Ark. and Kans., 2577; Arkansas River, Ark., 2581; White River, Ark., 2592; Upper White River, Ark., 2596; Buffalo Fork of White River, Ark., 2601; Cache River, Ark., 2602; Black River, Ark. and Mo., 2604; Current River, Ark. and Mo., 2608; St. Francis River, Ark., 2610; removing sunken vessels or craft obstructing or endangering navigation, 2613.
EXAMINATIONS.—Current River, Mo., 2614; St. Francis River, Mo., 2618.

APPENDIX Z.

REPORT OF CAPT. EDW. BURR, CORPS OF ENGINEERS.

IMPROVEMENTS.—Removing snags and wrecks from Mississippi River below Missouri River, 2621; Mississippi River between Ohio and Missouri rivers, 2631; harbor at St. Louis, Mo., 2664; to prevent the Mississippi River from breaking through into the Cache River at Beechridge, above Cairo, Ill., 2666.
EXAMINATIONS AND SURVEYS.—Mississippi River below Rockwood, Ill., 2667; Mississippi River at or near Beechridge, Ill., 2672.

APPENDIX A A.

REPORT OF MAJ. C. McD. TOWNSEND, CORPS OF ENGINEERS.

IMPROVEMENTS.—Operating snag boats and dredge boats on Upper Mississippi River, 2679; Mississippi River between mouth of Missouri River and St. Paul, 2692; operating and care of Des Moines Rapids Canal and Dry Dock, 2744; operating and care of Galena River improvement, Ill., 2752; harbor at La Crosse, Wis., 2755.
EXAMINATIONS AND SURVEY.—Mississippi River in vicinity of Quincy, Ill., 2756; Mississippi River opposite Bellevue, Iowa, 2759; east shore of Lake Pepin, Mississippi River, 2763.

APPENDIX B B.

REPORT OF MAJ. F. V. ABBOT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Mississippi River, between St. Paul and Minneapolis, Minn., 2768; construction of reservoirs at headwaters of Mississippi River, 2786; operating and care of reservoirs at headwaters of Mississippi River, 2800; Chippewa River, including yellow banks, Wis., 2806; St. Croix River, Wis. and Minn., 2809; Minne-

sota River, Minn., 2812; Red River of the North, Minn. and N. Dak., 2814; bar at mouth of Warroad River, Minn., 2820; gauging Mississippi River at or near St. Paul, Minn., 2821.

EXAMINATIONS AND SURVEYS.—Red Lake and Red Lake River, Minn., 2828; Otter Tail Lake and Otter Tail River, Minn., 2830; Big Stone Lake and Lake Traverse, Minn. and S. Dak., 2833; St. Croix River, Minn., 2836; Minnesota River, Minn., 2840; Red River of the North, Minn. and N. Dak., 2841.

APPENDIX C C.

REPORTS OF LIEUT. COL. AMOS STICKNEY, CORPS OF ENGINEERS, PRESIDENT MISSOURI RIVER COMMISSION.

PRELIMINARY examinations and surveys of Missouri River at Huntsdale and Napoleon, Mo., 2847, 2852.

APPENDIX D D.

REPORT OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Missouri River between Stubbs Ferry, Mont., and lower limits of Sioux City, Iowa, 2859; snagging Upper Missouri River, 2882.

APPENDIX E E.

REPORT OF LIEUT. COL. M. B. ADAMS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Obion River, Tenn., 2887; Forked Deer River, Tenn., 2889; Cumberland River, Tenn. and Ky., 2891.

PART V.

APPENDIX F F.

REPORT OF MAJ. DAN C. KINGMAN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Tennessee River, 2907; operating and care of Muscle Shoals Canal, Tennessee River, 2934; French Broad River and Little Pigeon River, Tenn., 2944; Clinch River, Tenn. and Va., 2948; Elk River, Tenn. and Ala., 2952.

EXAMINATIONS AND SURVEYS.—Tennessee River at the "Suck," or mountain section, below Chattanooga, Tenn., 2956; Tennessee River at Moccasin Bend, below Chattanooga, Tenn., 3005; Tennessee River between Bridgeport and Decatur, Ala., 3008; Hiwassee River, Tenn., 3010; French Broad River, Tenn., 3018; Holston River, Tenn., 3058; Clinch River, Tenn., 3065; Powells River, Va. and Tenn., 3067; Richland River, Tenn., 3074; Elk River, Tenn. and Ala., 3077.

APPENDIX G G.

REPORT OF MAJ. W. H. BIXBY, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ohio River, 3085; operating snag boat on the Ohio River, 3129; operating and care of Davis Island Dam, Ohio River, 3140; movable dams in Ohio River, 3146.

EXAMINATIONS AND SURVEYS.—Licking River, Ky., 3155; Ohio River from Mound City to Cairo, Ill., 3185; Ohio River at or near New Liberty, Ill., 3191; Ohio River from Marietta, Ohio, to mouth of Big Miami River, 3201; Ohio River at Madison, Ind., 3215; river bank at Paducah, Ky. (Tennessee River), 3219.

APPENDIX H H.

REPORT OF MAJ. CHAS. F. POWELL, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monongahela River, W. Va., 3225; Monongahela River, Pa., 3228; operating and care of locks and dams, Monongahela River, W. Va. and Pa., 3233; harbor of Pittsburg, Pa., 3254; construction of locks and dams at Herr Island, above head of Six-mile Island, and at Springdale, Allegheny River, 3257; Allegheny River, Pa., 3263.

EXAMINATIONS AND SURVEY.—West Fork River, W. Va., 3267; Youghiogheny River, Pa., from West Newton to its mouth, 3283.

APPENDIX I I.

REPORT OF CAPT. H. F. HODGES, CORPS OF ENGINEERS.

IMPROVEMENTS.—Muskingum River, Ohio, 3297; operating and care of locks and dams on Muskingum River, Ohio, 3300; Little Kanawha River, W. Va., 3317; operating and care of lock and dam on Little Kanawha River, W. Va., 3319; Kanawha River, W. Va., 3322; operating and care of locks and dams on Kanawha River, W. Va., 3325; Elk River, W. Va., 3337; Gauley River, W. Va., 3340; Guyandot River, W. Va., 3343; Big Sandy River, W. Va. and Ky., 3347; operating and care of lock and dam in Big Sandy River, W. Va. and Ky., 3353; Tug Fork of Big Sandy River, W. Va. and Ky., 3357; Levisa Fork of Big Sandy River, Ky., 3360; Kentucky River, Ky., 3363; operating and care of locks and dams in Kentucky River, Ky., 3369.

EXAMINATIONS AND SURVEY.—Elk River, W. Va., 3392; Guyandot River, W. Va., 3396; Big Sandy River, W. Va. and Ky., including Levisa and Tug forks, 3400.

APPENDIX J J.

REPORT OF CAPT. GEO. A. ZINN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Falls of the Ohio River at Louisville, Ky., 3463; operating and care of Louisville and Portland Canal, Ky., 3482; Wabash River, Ind. and Ill., 3497; operating and care of lock and dam at Grand Rapids, Wabash River, 3498; White River, Ind., 3500; Green river, Ky., 3501; operating and care of locks and dams on Green and Barren rivers, Ky., 3516; Rough River, Ky., 3539; operating and care of lock and dam in Rough River, Ky., 3541.

EXAMINATION.—Green River, Ky., 3542.

APPENDIX K K.

REPORT OF MAJ. CLINTON B. SEARS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Harbor at Grand Marais, Minn., 3547; harbor at Agate Bay, Minn., 3551; harbor at Duluth, Minn., and Superior, Wis., 3554; harbor at Ashland, Wis., 3592; harbor at Ontonagon, Mich., 3595; waterway from Keweenaw Bay to Lake Superior, Mich., 3598; harbor at Marquette, Mich., 3606; harbor of refuge, Marquette Bay, Mich., 3608; harbor of refuge at Grand Marais, Mich., 3610.

EXAMINATIONS AND SURVEYS.—Canal between Lake Superior and Mississippi River, 3613; harbor of refuge at Two Islands, or Saxton, Minn., 3629; harbor at Portwing, Wis., 3630; Copper Harbor, Mich., 3636.

HARBOR LINES.—Duluth and Superior Harbor, Minn. and Wis., 3642.

APPENDIX L L.

REPORT OF CAPT. J. G. WARREN, CORPS OF ENGINEERS.

IMPROVEMENTS.—Menominee Harbor, Mich. and Wis., 3650; Menominee River, Mich. and Wis., 3653; Oconto Harbor, Wis., 3654; Green Bay Harbor, Wis., 3657; Sturgeon Bay and Lake Michigan Ship Canal, Wis., 3659; operating and care of Sturgeon Bay and Lake Michigan Ship Canal, Wis., 3666; harbor of refuge at entrance of Sturgeon Bay and Lake Michigan Ship Canal, Wis., 3672; Ahnapee Harbor, Wis., 3674; Kewaunee Harbor, Wis., 3679; Two Rivers Harbor, Wis., 3681; Manitowoc Harbor, Wis., 3683; Sheboygan Harbor, Wis., 3687; Port Washington Harbor, Wis., 3692; harbor of refuge at Milwaukee, Wis., 3695; Milwaukee Harbor, Wis., 3697; South Milwaukee Harbor, Wis., 3701; Racine Harbor, Wis., 3702; Kenosha Harbor, Wis., 3706; Waukegan Harbor, Ill., 3709; Fox River, Wis., 3712; operating and care of locks and dams on Fox River, Wis., 3721.

EXAMINATIONS AND SURVEYS.—Menominee River, Mich. and Wis., 3739; harbor at Oconto, Wis., 3745; Green Bay Harbor, Wis., 3747; harbor at Kewaunee, Wis., 3752; harbor at Two Rivers, Wis., 3759; Manitowoc Harbor, Wis., 3761; harbor at Port Washington, Wis., 3766; harbor at Kenosha, Wis., 3767; Waukegan Harbor, Ill., 3769.

HARBOR LINES.—Kenosha, Wis., 3776.

APPENDIX M M.

REPORT OF MAJ. J. H. WILLARD, CORPS OF ENGINEERS.

IMPROVEMENTS.—Chicago Harbor, Ill., 3779; Chicago River, Ill., 3784; Calumet Harbor, Ill., 3788; Calumet River, Ill. and Ind., 3792; Illinois River, Ill., 3798; operat-

ing and care of Lagrange and Kampsville Locks and Dams, Illinois River, 3805; Illinois and Mississippi Canal, 3810; operating and care of Illinois and Mississippi Canal (canal around lower rapids of Rock River, Ill.), 3853.

EXAMINATION AND SURVEY.—Upper Illinois and Lower Des Plaines rivers, Ill., 3855; Chicago River, Ill., 3863.

APPENDIX N N.

REPORT OF CAPT. CHESTER HARDING, CORPS OF ENGINEERS.

IMPROVEMENTS.—Michigan City Harbor, Ind., 3873; St. Joseph Harbor, Mich., 3879; St. Joseph River, Mich., 3883; South Haven Harbor, Mich., 3884; Saugatuck Harbor, Mich., 3887; Kalamazoo River, Mich., 3890; Holland (Black Lake) Harbor, Mich., 3891; Grand Haven Harbor, Mich., 3895; Grand River, Mich., 3899; Muskegon Harbor, Mich., 3905; White Lake Harbor, Mich., 3909; Pentwater Harbor, Mich., 3913; Ludington Harbor, Mich., 3916; Manistee Harbor, Mich., 3919; harbor of refuge at Portage Lake, Manistee County, Mich., 3922; Frankfort Harbor, Mich., 3925; Charlevoix Harbor, Mich., 3928; Petoskey Harbor, Mich., 3932; removing sunken vessels or craft obstructing or endangering navigation, 3933.

EXAMINATIONS.—Muskegon River, Mich., 3934; channel from Lake Michigan to Stony Lake, Mich., 3939; Arcadia, Mich., 3942.

PART VI

APPENDIX O O.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Ship canal connecting the waters of the Great Lakes between Chicago, Duluth, and Buffalo, 3947; St. Marys River at the Falls, Mich., 3952; operating and care of St. Marys Falls Canal, Mich., 3956; Hay Lake Channel, St. Marys River, Mich., 3969; Cheboygan Harbor, Mich., 3973; Alpena Harbor (Thunder Bay River), Mich., 3975; Saginaw River, Mich., 3978; Sebewaing River, Mich., 3981; harbor of refuge at Sandbeach, Lake Huron, Mich., 3983; mouth of Black River, Mich., 3986; Black River at Port Huron, Mich., 3987; Pine River, Mich., 3989; Belle River, Mich., 3991; St. Clair Flats Canal, Mich., 3993; operating and care of St. Clair Flats Canal, Mich., 3994; Clinton River, Mich., 3996; Detroit River, Mich., 3997; Rouge River, Mich., 4006.

EXAMINATIONS AND SURVEYS.—Mackinac Harbor, Mich., 4008: Cheboygan Harbor, Mich., 4012; Detroit River, Mich., 4015.

APPENDIX P P.

REPORT OF COL. JARED A. SMITH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Monroe Harbor, Mich., 4019; Toledo Harbor, Ohio, 4022; Port Clinton Harbor, Ohio, 4038; Sandusky Harbor, Ohio, 4042; Huron Harbor, Ohio, 4051; Black River (Lorain) Harbor, Ohio, 4054; Cleveland Harbor, Ohio, 4063; Fairport Harbor, Ohio, 4070; Ashtabula Harbor, Ohio, 4075; breakwater construction at harbors on Lake Erie, 4084; Conneaut Harbor, Ohio, 4091; removing sunken vessels or craft obstructing or endangering navigation, 4094.

APPENDIX Q Q.

REPORT OF MAJ. T. W. SYMONS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Erie Harbor, Pa., 4099; harbor at Dunkirk, N. Y., 4108; Buffalo Harbor, N. Y., 4113; Buffalo entrance to Erie Basin and Black Rock Harbor, N. Y., 4135; Tonawanda Harbor and Niagara River, N. Y., 4138; Niagara River from Tonawanda to Port Day, N. Y., 4144.

EXAMINATIONS AND SURVEY.—Dunkirk Harbor, N. Y., 4148; Tonawanda Harbor and Creek, N. Y., 4152.

HARBOR LINES.—Buffalo Harbor, N. Y., 4156; Niagara River at North Tonawanda, N. Y., 4159.

APPENDIX R R.

REPORT OF CAPT. GRAHAM D. FITCH, CORPS OF ENGINEERS.

IMPROVEMENTS.—Wilson Harbor, N. Y., 4161; harbor at Charlotte, N. Y., 4163; harbor at Pultneyville, N. Y., 4165; harbor at Great Sodus Bay, N. Y., 4166; harbor at Little Sodus Bay, N. Y., 4168; Oswego Harbor, N. Y., 4170; harbor at Cape Vincent, N. Y., 4173; shoals in the St. Lawrence River between Ogdensburg and foot of Lake Ontario, 4175; Ogdensburg Harbor, N. Y., 4177; removing sunken vessels or craft obstructing or endangering navigation, 4180.

APPENDIX S S.

REPORT OF CAPT. JAMES J. MEYLER, CORPS OF ENGINEERS.

IMPROVEMENTS.—San Diego Harbor, Cal., 4181; deep-water harbor at San Pedro Bay, Cal., 4187; Wilmington Harbor, Cal., 4191; San Luis Obispo Harbor, Cal., 4192.
EXAMINATION AND SURVEY.—Inner harbor, San Pedro Harbor, Cal., 4194.

APPENDIX T T.

REPORT OF LIEUT. COL. WM. H. HEUER, CORPS OF ENGINEERS.

IMPROVEMENTS.—Alviso Harbor, Cal., 4213; San Francisco Harbor, Cal., 4215; Oakland Harbor, Cal., 4218; San Joaquin River, Cal., 4223; Mokelumne River, Cal., 4226; Sacramento and Feather rivers, Cal., 4227; Sacramento River, Cal., from Sacramento to the mouth, 4230; Napa River, Cal., 4234; Petaluna Creek, Cal., 4236; Humboldt Harbor and Bay, Cal., 4237.
EXAMINATIONS.—Harbor at South San Francisco, Cal., 4248; Suisun Creek, Cal., 4250; Napa River, Cal., 4253; Sonoma Creek, Cal., 4256; channel between Straits of Karquines and the Golden Gate, Cal., 4258; Crescent Bay (Crescent City Harbor), Cal., 4262.

APPENDIX U U.

REPORT OF CAPT. WM. W. HARTS, CORPS OF ENGINEERS.

IMPROVEMENTS.—Port Orford Harbor, Oreg., 4265; Coquille River, Oreg., 4266; Coquille River, Oreg., between Coquille and Myrtle Point, 4271; entrance to Coos Bay and Harbor, Oreg., 4274; Coos Bay, Oreg., 4280; Coos River, Oreg., 4283; Siuslaw River, Oreg., 4286; Yaquina Bay, Oreg., 4291; examination Yaquina Bay, Oreg., 4293; Tillamook Bay and Bar, Oreg., 4314; Upper Columbia and Snake rivers, Oreg. and Wash., 4319; Columbia River at Three-mile Rapids and boat railway from The Dalles Rapids to Celilo Falls, 4322; canal at the Cascades, Columbia River, Oreg., 4324; operating and care of canal and locks at the Cascades, Columbia River, 4329; Columbia River between Vancouver, Wash., and mouth of Willamette River, 4334; Clearwater River, Idaho, 4337.
EXAMINATION.—Snake River, Wash., 4338.

APPENDIX V V.

REPORT OF CAPT. W. C. LANGFITT, CORPS OF ENGINEERS.

IMPROVEMENTS.—Long Tom River, Oreg., 4346; Willamette River above Portland, and Yamhill River, Oreg., 4347; Columbia and Lower Willamette rivers below Portland, Oreg., 4352; Columbia River, Oreg., below Tongue Point, 4360; mouth of Columbia River, Oreg. and Wash., 4361; Clatskanie River, Oreg., 4363; Lewis River, Wash., 4364; Cowlitz River, Wash., 4366; gauging Columbia River, Oreg. and Wash., 4368.
EXAMINATIONS AND SURVEYS.—Canal and locks at Willamette Falls, Willamette River, Oreg., 4368; Lower Willamette and Columbia rivers below Portland, Oreg., 4416; mouth of Columbia River, Oreg. and Wash., 4430.
HARBOR LINES.—Willamette River at Portland, Oreg., 4456.

APPENDIX W W.

REPORT OF CAPT. HARRY TAYLOR, CORPS OF ENGINEERS.

IMPROVEMENTS.—Willapa River and Harbor, Wash., 4463; Grays Harbor and bar entrance, Wash., 4468; Chehalis River, Wash., 4476; Puget Sound and its tributary waters, Wash., 4477; Olympia Harbor, Wash., 4481; waterway connecting Puget Sound with lakes Union and Washington, 4483; Everett Harbor, Wash., 4485; Swinomish Slough, Wash., 4487; Okanogan River, Wash., 4489; Pend Oreille River, Wash., 4494; Kootenai River, Idaho, between Bonners Ferry and the international boundary line, 4500; Flathead River, Mont., 4501.
EXAMINATION AND SURVEY.—Neah Bay, Wash., 4502.

APPENDIX X X.

REPORT OF LIEUT. COMMANDER JOHN C. FREMONT, U. S. N., SUPERVISOR.

SUPERVISION of the harbor of New York, 4513.

PART VII.

APPENDIX Y Y.

REPORT OF THE MISSISSIPPI RIVER COMMISSION.

G. L. GILLESPIE, colonel, Corps of Engineers, U. S. A., president; Amos Stickney, lieutenant-colonel, Corps of Engineers, U. S. A.; Thos. H. Handbury, major, Corps of Engineers, U. S. A.; Henry L. Marindin, assistant, United States Coast and Geodetic Survey; B. M. Harrod, Robert S. Taylor, and J. A. Ockerson, commissioners.
ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1900, 4525.
APPENDIX 1.—Paper by Maj. Geo. McC. Derby, Corps of Engineers, on changes in flood heights, fourth district, Mississippi River, 4551.
APPENDIX 2.—Report of Capt. Mason M. Patrick, Corps of Engineers, secretary of the Mississippi River Commission, on work done in office of Commission on surveys, gauges, and observations, dredges and dredging, and on experimental dikes, 4557; (A) laws affecting the Mississippi River Commission July 1, 1899, to June 30, 1900, 4574; (B) specifications for the construction of self-propelling hydraulic dredges *Kappa* and *Henry Flad*, 4575; (C) specifications for the construction of refrigerating plants, dredge *Iota*, and large tenders, 4600; (D) report of Assistant Engineer A. T. Morrow on work done by the topographical party under his charge, and on reconnaissance made by Assistant Engineer Geo. H. French during the field season of 1899, 4603; (E) report of surveyor W. S. Williams on precise-level work from Baton Rouge, La., to mouth of South Pass, in 1897–98, and from Fort Adams, Miss., to Baton Rogue, La., and New Orleans, La., to Biloxi, Miss., in 1900, 4622; (F) report of Assistant Engineer Kivas Tully on work pertaining to gauges, reduction of physical data, office records and publications, 4740; (G) report of Assistant Engineer C. W. Sturtevant on dredging operations on the Mississippi River between Cairo, Ill., and Head of Passes, La., and on care and repair of plant, 4759; (H) report of Assistant Engineer William Gerig on experimental dike work, 4778.
APPENDIX 3.—Report of Capt. E. E. Winslow, Corps of Engineers, upon operations in the first and second districts, 4783; report of Assistant Engineer Aug. J. Nolty, on construction work in first district during season of 1899–1900, 4796; report of Assistant Engineer W. M. Rees, on work in first and second districts during season of 1899–1900, 4808; report of Assistant Engineer Charles Levasseur, on dredging operations in Wolf River, season of 1899–1900; report of Assistant Engineer Aug. J. Nolty, on care and repair of plant, 4817.
APPENDIX 4.—Report of Capt. Charles L. Potter, Corps of Engineers, of operations in third district, 4824; report of Assistant Engineer Arthur Hider, on surveys, revetment work, stone, and the care and repair of plant, 4830; report of Assistant Engineer H. St. L. Coppee, on levees in the Lower Yazoo Levee district, 4847; report of Assistant Engineer E. C. Tollinger on levees in the Upper Tensas Levee district, 4854.
APPENDIX 5.—Report of Maj. Geo. McC. Derby, Corps of Engineers, of operations in the fourth district, 4875; (A) approximate value of plant, 4910; (B) commercial statistics, port of New Orleans, 4910; (C) list of civilian engineers, 4911; (D) report of Assistant Engineer H. S. Douglas, on work at Kempe Bend, Natchez, and

Vidalia harbors, and care and preservation of plant, 4911; report of Assistant Engineer A. F. Woolley, jr., on work on Atchafalaya and Red rivers, La., 4919; (F) report of Assistant Engineer A. F. Woolley, jr., on concrete ballast, 4921; (G) abstract of proposals, 4924; (H) list of contracts in force, 4933.

APPENDIX Z Z.

REPORT OF THE MISSOURI RIVER COMMISSION.

AMOS STICKNEY, lieutenant-colonel, Corps of Engineers, U. S. A., president; Thos. H. Handbury, major, Corps of Engineers, U. S. A.; W. L. Marshall, major, Corps of Engineers, U. S. A.; G. C. Broadhead, and C. L. Chaffee, commissioners.
ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1900, 4935.
APPENDIX A.—Annual report on water gauges, by Assistant Engineer A. H. Blaisdell, 4955.
APPENDIX B.—Annual report on commercial statistics, by Assistant Engineer A. H. Blaisdell, 4956.
APPENDIX C.—Annual report on Omaha Division, by Division Engineer S. Waters Fox, 4963.
APPENDIX D.—Annual report on Gasconade Division, by Division Engineer S. Waters Fox, 4973.
APPENDIX E.—Annual report on local works below Kansas City, Mo., by Division Engineer S. Waters Fox, 4981.
APPENDIX F.—Annual report on the Osage River, by Assistant Engineer F. B. Maltby, 5000.
APPENDIX G.—Annual report on the Gasconade River, by Assistant Engineer F. B. Maltby, 5004.

PART VIII.

APPENDIX A A A.

REPORT OF THE CALIFORNIA DÉBRIS COMMISSION.

S. M. MANSFIELD, colonel, Corps of Engineers, U. S. A., president; Wm. H. Heuer, major, Corps of Engineers, U. S. A.; Herbert Deakyne, first lieutenant, Corps of Engineers, U. S. A., commissioners.
ANNUAL REPORT FOR FISCAL YEAR ENDING JUNE 30, 1900, 5007.
SYNOPSIS of applications for authority to mine, with action taken thereon, 5010; protection of Sacramento and Feather rivers, Cal., 5030; report of Assistant Engineer Hubert Vischer, relative to storage of mining detritus on Yuba River, 5035; laws relating to California Débris Commission, 5064.

APPENDIX B B B.

DETERIORATION OF RIVER AND HARBOR WORKS, AND DISCONTINUANCE OF APPROPRIATIONS FOR RIVER AND HARBOR WORKS DEEMED NOT WORTHY OF FURTHER IMPROVEMENT..... 5071

APPENDIX C C C.

OCCUPATION OF PUBLIC RIVER AND HARBOR WORKS BY PRIVATE PARTIES..... 5085

APPENDIX D D D.

EXTENSION AND MODIFICATION OF HARBOR LINES IN HONOLULU HARBOR, HAWAII..... 5095

APPENDIX E E E.

REPORT OF BOARD OF ENGINEERS ON BILL H. R. 1065, FIFTY-SIXTH CONGRESS, FIRST SESSION, TO AUTHORIZE THE CONSTRUCTION OF BRIDGES ACROSS THE OHIO, MONONGAHELA, MISSISSIPPI, KANAWHA, TENNESSEE, CUMBERLAND, AND ILLINOIS RIVERS, AND TO PRESCRIBE THE DIMENSIONS OF THE SAME 5103

APPENDIX F F F.

REPORT OF LIEUT. COL. CHAS. J. ALLEN, CORPS OF ENGINEERS.

REPAIR of Aqueduct Bridge, Potomac River, Washington, D. C., 5123; memorial bridge across Potomac River at Washington, D. C., 5125.

APPENDIX G G G.

REPORT OF LIEUT. COL. A. M. MILLER, CORPS OF ENGINEERS.

WASHINGTON Aqueduct, 5193; increasing the water supply of Washington, D. C., 5208; investigating the water supply of Washington, D. C., 5224; Washington Aqueduct, D. C., filtration plant, 5224.

APPENDIX H H H.

REPORT OF COL. THEO. A. BINGHAM, U. S. ARMY.

IMPROVEMENT and care of public buildings and grounds in the District of Columbia, 5227, 5237; Washington Monument, 5233; buildings occupied as offices by the War Department, except State, War, and Navy Departments building, 5236; departmental telegraph line, 5262; extensions of buildings beyond the building lines in the city of Washington, 5264; unlawful occupation of Government reservations, 5264; statues, 5264; monument and wharf at Wakefield, Va., 5266; United States wharf property at Washington, D. C., 5266; summary of work done, 5267; (A) legal status of the office of public buildings and grounds, 5273; (B) list of trees and shrubs in the public grounds, Washington, D. C., 5286.

APPENDIX I I I.

SURVEY OF NORTHERN AND NORTHWESTERN LAKES.

REPORT of Lieut. Col. G. J. Lydecker, Corps of Engineers, 5317; report of Capt. Graham D. Fitch, Corps of Engineers, on preservation of bench marks along the Erie Canal, 5402; water levels, 5402.

APPENDIX J J J.

REPORT OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS.

IMPROVEMENT of the Yellowstone National Park, including the construction, repair, and maintenance of roads and bridges, 5403.

APPENDIX K K K.

RECONNOISSANCES, EXPLORATIONS, AND WORK IN THE FIELD, IN MILITARY DIVISIONS AND DEPARTMENTS.

REPORT of Capt. John Biddle, Corps of Engineers, chief engineer, Division of the Philippines, 5445; report of Capt. W. V. Judson, Corps of Engineers, engineer officer, Department of Porto Rico, 5449; report of Capt. Henry P. McCain, Fourteenth Infantry, engineer officer, Department of the Columbia, 5450; report of Capt. John B. Bennet, Sixteenth Infantry, acting engineer officer, Department of the Colorado, 5451.

APPENDIX L L L.

REPORT OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS.

CONSTRUCTION of military road from Fort Washakie to mouth of Buffalo Fork of Snake River, Wyo., 5453.

APPENDIX M M M.

REPORT OF CAPT. H. M. CHITTENDEN, CORPS OF ENGINEERS.

ERECTION of a monument to Sergt. Charles Floyd, 5455.

LAWS AFFECTING THE CORPS OF ENGINEERS, FIFTY-SIXTH CONGRESS, FIRST SESSION, 1899–1900 5459

APPENDIXES

TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

APPENDIX Y Y.

ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1900.

ARMY BUILDING,
New York City, June 30, 1900.

SIR: The Mississippi River Commission has the honor to submit its annual report for the fiscal year ending June 30, 1900.

The sundry civil act of March 3, 1899, appropriated the sum of $2,583,333 for the improvement of the Mississippi River, from which the following allotments were made prior to June 30, 1899:

Mississippi River Commission	$35,000
Surveys, gauges, and observations	70,000
Dredges and dredging	358,400
Experimental low-water dikes	50,000
Plum Point Reach, repair and preservation of works	60,000
Hopefield Bend, repair and preservation of works	60,000
Plant, First and Second districts	25,000
Surveys, First and Second districts	5,000
Ashbrook Neck, repair and preservation of works	20,000
Lake Providence revetment, repair and extension	60,000
Plant, Third district	60,000
Surveys, Third district	5,000
Kempe Bend revetment	180,000
Plant, Fourth district	64,444
Surveys, Fourth district	5,000
Levees	1,250,000
Hickman, Ky., repairs to revetment	6,000
Greenville, Miss., repairs to revetment	26,000
Bondurant, La., bank protection	10,000
Reserved for future allotment	78,489

The same act also specifically provided for the expenditure of the sums named at the following points:

New Madrid, Mo., Harbor	$40,000
Caruthersville, Mo., Harbor	35,000
Helena, Ark., Harbor	30,000
Greenville, Miss., Harbor	50,000

The river and harbor act of March 3, 1899, provided for the expenditure of the following amounts under the direction of the Mississippi River Commission:

Harbor of Natchez and Vidalia, Miss. and La.	$50,000
Harbor of New Orleans	110,000
Rectification of Red and Atchafalaya rivers	25,000

From the sum of $78,489, reserved for future allotments from the appropriation made by the sundry civil act of March 3, 1899, the following allotments were subsequently made to meet emergencies or changes in condition of the several works in charge of the Commission:

Plum Point Reach, repairs to revetment	$8,000
Ashport Bend, repairs to revetment	20,000
Bondurant, bank protection at	10,000
Mississippi River Commission	40,489
	78,489

The sundry civil act of June 6, 1900, appropriated the sum of $2,250,000 for continuing the improvement of the Mississippi River from Cairo to the Passes, from which the following allotments have been made:

Surveys, gauges, and observations	$40,000
Dredges and dredging	400,000
Surveys, First and Second districts	5,000
Levees:	
Upper St. Francis district	20,000
Lower St. Francis district	114,500
White River district	50,000
Upper Yazoo district	94,000
Lower Yazoo district	150,000
Upper Tensas district	300,000
Lower Tensas district	110,000
Atchafalaya district	55,000
Lafourche district	28,000
Barataria district	14,000
Pontchartrain district	50,000
Lake Borgne district	14,500
Plum Point Reach	80,000
Hopefield Bend	50,000
Plant	25,000
Experimental dikes	20,000
Surveys, Third district	5,000
Ashbrook Neck revetment	70,000
Lake Providence revetment	75,000
Repairs to existing works	50,000
Stone	50,000
Plant	25,000
Surveys, Fourth district	5,000
Kempe Bend revetment	150,000
Giles Bend revetment	150,000
Plant	25,000
Reserved for allotment at discretion of president of the Mississippi River Commission	25,000
Total	2,250,000

The sundry civil act of March 3, 1899, terminated the second four-year continuing appropriation for the improvement of the Mississippi River. After an experience of eight years in administering the work of the Government under this system, the Commission feels qualified to express an opinion in favor of its efficiency and economy in connection with the works in its charge. The assurance of a regular and uniform appropriation makes possible more foresight and system in both office and field on the part of the Commission and of the engineers in immediate charge of the work. With the expectation of continuous service a stronger corps of assistants and employees can be organized, and contractors of larger means and better equipment are attracted. Better administration and rates are therefore obtained. On account of the character of the work, and the climate in which it is conducted, a large part of the cost of the improvement is in the building, repair, and preservation of plant. Deterioration goes on at a rapid rate irrespective of use. It is therefore of much economic importance to keep it constantly employed; to wear it out rather than let it rot. Without regularity in appropriations the part of each which it is necessary to reserve as a precaution in order to lay up and preserve the plant and to protect the work during an indefinite interval before the resumption of operations reduces the quantity of work done, postpones results, and increases costs. These are some of the

considerations which make for economy in the system of continuing appropriations which we have the honor to recommend.

The first continuing appropriation made for the improvement of the Mississippi River, in the river and harbor act of 1892, received an interpretation which allowed the Commission to make continuing contracts, only limited by the time and amount fixed by the appropriation act. The second continuing appropriation, in the river and harbor act of 1896, was interpreted as limiting the right of contract of the Commission to the year and amount for which each appropriation was made. It is the experience of the Commission that, if not inconsistent with other interests, the former system, allowing contracts limited only by the time and amount for which the Government, in the original act, has declared its intention to make appropriations, allows the use of the advantages which have been cited to a greater extent than does the act of 1898.

MISSISSIPPI RIVER COMMISSION.

Capt. Mason M. Patrick, Corps of Engineers, U. S. A., secretary; office, Fullerton Building, corner Pine and Seventh streets, St. Louis, Mo.

During the past year the Mississippi River Commission held three sessions. The first two were held at the office of the Commission, St. Louis, on November 4, 1899, and March 14, 1900, and both were followed by inspections of the river from St. Louis to New Orleans, and of the works in progress. During these inspections daily meetings were held for the transaction of the Commission's business, and with corporations or citizens interested in local improvements. The last meeting was held June 25 to 28, 1900, at the Army Building, New York City, after the passage of the sundry civil bill making an appropriation for the coming fiscal year, for the purpose of considering the distribution of the sum provided for the improvement of the Mississippi River, and for the preparation of the annual report.

SURVEYS, GAUGES, AND OBSERVATIONS.

The survey of the river from the head waters to the Head of the Passes, the preservation and recording of gauges and plant, and the observation of the hydraulic data necessary for a proper study of the improvement of the river have received attention during the year.

The topography and hydrography have been completed from the Head of the Passes up to St. Paul, Minn. Beyond this the precise leveling has been extended to Aitkin, Minn., and between these two points much of the other field work has been done. A reconnaissance has been made to the drainage basin of Lake Itasca, and over the intermediate parts of the river. Beside the levels following the course of the stream, side lines connect with Lake Michigan at Chicago and with Lake Superior at Duluth. Other lines of great importance have also been rerun from New Orleans to connect with the Gulf of Mexico at the mouth of the Mississippi River, and at Biloxi, Miss. The object of these was to investigate the subsidence of bench marks at and about the Passes of the river which previous levels had indicated. They seem to establish a settlement of about 1 foot in eighteen years at Port Eads, as referred to Biloxi. The subject is of sufficient interest and importance to be followed by connecting the bench marks in the alluvial

deposits about the lower parts of the Mississippi River and its Passes with others in the tertiary formation of Mississippi, which may be assumed as permanent, and checking their relative levels at intervals, as well as by the continuance of tidal observations at Biloxi and East Bay. Evidences of a geological subsidence of the Gulf coast of Louisiana and other States to the eastward have been observed; but, from its rapidity, it is probable that the settlement at South Pass indicated by these levels is rather the result of the compression by its own weight of the loosely deposited material at the mouth of the river than of an earth movement.

Besides these surveys, the work of the Commission's office at St. Louis has included investigations of the relative scour and fill in pools and on bars, the maintenance and recording of gauges, observations of the extremes and slopes of high and low water, discharge measurements at different stages, the care of the surveying plant and outfit, the reduction of field notes, the preparation and publication of charts, the designing of new dredges and dredging outfit, the care thereof, their operation when required by low stages in the river, and also the conduct of experimental dike work for low-water improvement. These duties may be described as follows:

Great importance attaches to the transfer of deposited material from bar to pool, and from pool to bar, during the different stages of the river year. To study these, an observation party has been stationed at New Madrid to repeat cross sections over a length of river in which bar, pool, and reversion point are found. The results of the year's observations have not yet been reduced.

The established gauges require annual inspection and repair in order to give certainty to this most important of all river records. This record is complete for nearly thirty years, and serves the interests of navigation, channel improvement, and levee building.

Maximum and minimum stages of each year's water are observed, at intervals not exceeding 5 miles, from Cairo to Fort Jackson. These records are of importance in ascertaining the effect of channel improvement and levees, both on the height of the floods and the bed of the river. Discharge measurements at high and low stages continue to be taken as frequently as the opportunity occurs.

For these series of observations an extensive outfit of boats, tools, and instruments are required, and the maintenance of these in such condition as to be available for service at the extremes of high and low water, as well as at intermediate periods, is important.

The Commission publishes three maps, viz: One of the alluvial valley, from the Passes to the head waters, on a scale of 1 inch to 5 miles; another of the river, within the same limits, on a scale of 1 inch to 1 mile, and detailed charts of the river, on a scale of 1 to 20,000. The first is complete, as is also the second from the Gulf to Lansing, Iowa, in 60 sheets, and the third from the Head of the Passes to La Crosse, Wis., in 155 sheets. The results of comparative surveys are added to these maps, and a record of works of improvement placed on them. The reduction of field notes, mapping, drawing, and other preparation for publication require a considerable office force.

The building, maintenance, and operation of dredges constitute a large part of the work of the Commission. The project which was adopted in 1896 for the improvement of low-water navigation by hydraulic dredges of capacity sufficient to open a channel through a bar,

in very few days, wide and deep enough to give relief to navigation, and, to a great extent, to direct the flow of the current along the line of least resistance, has met with sufficient success to justify its continuance. A navigable depth of 8½ feet was maintained during the past low-water season from Cairo to New Orleans.

The Commission had in the field during the season five dredges. One or more of them, as occasion required, were in operation from August 11 to November 26. An auxiliary fleet of towboats and tenders is necessary for the operation of these dredges.

It is expected that during the coming low-water season there will be nine dredges in commission.

The successful opening of a low-water channel through a bar depends largely upon the water conditions presented by the season and upon the skill with which a location is made. Experience shows that if the stage remains constant or steadily falls a channel once opened will remain in good condition throughout low water; also, that if it is located on lines that the current in seeking a crossing will readily follow, it will not only remain open but will steadily improve. This is clearly shown in the accompanying plates, 6–50, and particularly in those of Cherokee, Hickmans, Island 34, Presidents Island, and Fleeces crossings.

The dredges under construction are designed to be self-propelling, with the expectation of reducing the cost and time of operation and of removal from point to point. Other changes have, from time to time, been made to decrease cost and increase efficiency, and it is the intention of the Commission during the coming season to make a careful investigation as to the type of pump best adapted to deal with water discharged at high velocities and heavily charged with sand. Reference is invited to the report of Capt. Mason M. Patrick, Corps of Engineers, U. S. A., secretary of the Commission, Appendix 2, for a full description of the dredging fleet, the proposed additions, its operations, and the directions in which investigations have been and are being made to increase its efficiency.

It is the opinion of the Commission that hydraulic dredging has proved to be a successful, economical, and reliable means of low-water channel improvement, and that such part of the attention and funds at the disposal of the Commission as is necessary should be devoted to its further development.

Experimental dike work for the relief of navigation during the low stages was tried at two places, Point Pleasant and Cherokee Crossing. It is not thought that either the season or the locations were favorable, so the results are not conclusive as to the merits of such structures, when required at critical times and over extensive areas.

For further details of all the foregoing work of the Commission, reference is invited to the report before mentioned, of the secretary, Captain Patrick, and to those of his assistant engineers.

CHANNEL WORKS AND BANK REVETMENT IN THE SEVERAL DISTRICTS.

Works above Cairo.—Office at custom-house, St. Louis, Mo., Capt. Edward Burr, Corps of Engineers, U. S. A.

The river and harbor act of July 5, 1884, appropriated $50,000 for the purpose of extending the revetment work which had been put in to check the bank erosion in the rear of Cairo, Ill., the work to be

done under the direction of the Mississippi River Commission. Mattress work and repairs to stone paving were done there in 1884 to 1886 and some additional repairs were made in 1898. The work has been entirely successful, and no work has been necessary during the past year. An unexpended balance of $7,361 remains on hand.

First district, from Cairo, Ill., to foot of Island 40, 220 miles.—Office, 36 Equitable Building, Memphis, Tenn.; district officer, Capt. E. Eveleth Winslow, Corps of Engineers, U. S. A.

Construction work for channel improvement and for the protection of caving banks has been done by the Commission at the following localities in this district during the past fiscal year:

Hickman, Ky., 36 miles below Cairo, left bank.—Work was necessary here to repair injury done to the revetment by the discharge of local drainage, at a cost to the Government of over $2,500. Otherwise the work has remained in good condition.

New Madrid, Mo., 71 miles below Cairo, right bank.—The work of bank protection previously done at this point, 3,650 feet long, remained in good condition, the repairs needed being few and slight. The season's work consisted of a downstream extension of the revetment, giving it an aggregate length of 4,600 feet, and the placing of small mats at the mouths of two bayous below the town where washouts had occurred. The present length of the revetment fully protects that part of the bank occupied by the town.

Caruthersville, Mo., 110 miles below Cairo, right bank.—The rapid caving of the bank on which that town is situated led to appropriations in the sundry civil acts of 1898 and 1899 for its protection. The work has been actively prosecuted during the two past working seasons, and now has an extension, in good condition, of 1,890 feet. It is important that the work should be extended some distance downstream, and that the upper bank revetment should be carried to a higher level. Injury has also been done here to the work by the mismanagement of the local drainage, such as has been reported on at Hickman.

Plum Point Reach, 147 to 186 miles below Cairo.—The year's work at this well-known part of the river consisted in the necessary repairs of 63,000 linear feet of revetment, and of the dike and dam systems for the closure of Elmot and Island 30 chutes. The extreme width of the river here, and its subdivision into competing channels, makes the maintenance of these last-mentioned works of great importance. Daniels Point revetment, 8,800 feet long, needed extensive repairs. Ashport Bend revetment, 19,234 feet long, is generally in good order, and the repairs needed were slight. Fletchers Bend, in which 17,700 linear feet of bank protection has been built, needed extensive repairs; 16,300 feet of it now stands in good condition. Osceola Bar revetment, 5,500 feet long, also required repairs.

Much of the work of maintenance necessary this year was due to the fact that the work was among the earliest done on the river, and at a time when the methods of construction were far inferior to those now used.

The Gold Dust Dam, which, for the reasons before given, is a work of much importance in connection with the navigation of the reach, also received repair, partly in closing a gap and partly in restoring the grade which had been lost by settlement. After this repair work was completed further damage occurred, and other methods of closing this chute will be investigated.

The 12 miles of levee which was built along the left bank of the reach and is thought to have contributed materially to the improvement of local navigation, received injury in the flood of 1897, and should be restored to its former efficiency.

Reference is invited to the report of Capt. E. E. Winslow, executive officer of the district, and to those of his assistant engineers, for a full description of the improvements on this part of the river and for details of the season's work. (Appendix 3.)

Second district, from the foot of Island 40 to the mouth of White River, 175 miles.—Office, 36 Equitable Building, Memphis, Tenn.; district officer, Capt. E. Eveleth Winslow, Corps of Engineers, U. S. A.

Hopefield Bend, Arkansas, 227–230 miles below Cairo, right bank.—This revetment was completed in 1889, with a length of 16,200 feet. Since then repairs have been made from time to time. It now stands in good condition. It is a work of the greatest importance, since upon the prevention of further recession of Hopefield Bend and Point by this bank protection depends the preservation of Memphis Harbor. The loss of Hopefield Point means a sand bar along the Memphis front. In fact, during the delay in the completion of the revetment from the failure of appropriations, the point receded far enough to cause the loss by deposit of a large part of the upper end of the harbor. Considerable work has been done on the revetment during the past season, mainly in replacing the older and inferior work, which showed signs of weakness, with mats built by more recent and reliable methods. It is thought advisable that a short downstream extension be built around the point, and that the upper bank revetment of stone be carried, in places, to a higher level.

Wolf River, 230 miles below Cairo, left bank.—This work of improvement, started under an appropriation in the river and harbor act of 1896, consists in keeping a small stream, tributary to the Mississippi at the upper limit of the city of Memphis, free from the deposit caused by back water and from the sawmill and manufacturing refuse annually sunk in it. It is of considerable local commercial importance, but its navigable condition is dependent upon annual appropriations and work. A dredge boat has been acquired, and dump scows will be ready for the work of the coming low-water season.

Memphis Harbor, 230–232 miles below Cairo, left bank.—The revetment work protecting the harbor front of Memphis was built jointly by the Government and the citizens. It was commenced in 1884 above the city, and the last extension, built in 1898, connected with the revetment of the railroad company protecting the bridge pier below the city. Whatever repairs were needed have been made by the Government. It is now in good condition, but its importance is such that funds should be available for repairs at any time.

Helena Harbor, 306 miles below Cairo, right bank.—This improvement has an extension of 4,900 feet along the lower part of the city front. During the past year the work consisted of both repairs and extensions. It is now in good condition, but the building of the upper bank revetment to a higher level is considered advisable.

Reference is invited to the report of Capt. E. E. Winslow, executive officer of the district, and to the reports of his assistant engineers for full description of the work in this part of the river and for details of the season's work. (Appendix 3.)

Third district, from the mouth of the White River to Warrenton, Miss,, 214 miles.—Office, 64 Equitable Building, Memphis, Tenn.; district officer, Capt. H. C. Newcomer, Corps of Engineers, U. S. A., until December 30, 1899, and from that date, Capt. C. L. Potter, Corps of Engineers, U. S. A.

Improvement work, under the Mississippi River Commission, has been conducted at the following localities in this district: Ashbrook Neck, Greenville, Lake Providence, and Delta Point.

Ashbrook Neck, 446 miles below Cairo, left bank.—This work was inaugurated ten years ago to prevent a cut-off in the extremely tortuous part of the river between Arkansas City and Greenville, known as "The Bends." Of three exceedingly elongated points, Ashbrook was chosen as the most threatening, being some 12 miles around and only about 2,000 feet across. The protection commenced in 1890 has been extended over a length of bank of nearly 10,000 feet. Necessary repairs have been made from time to time, some during the past season. The work is now in good condition, but will, in the early future, need both repair and an extension upstream, as caving has become more active above the head of the work.

Greenville (Miss.) Harbor, 478 miles below Cairo.—Work was commenced on the Greenville front in 1887, at which time the site of the town was threatened by rapid caving. The earliest work was a system of spur dikes, which was changed in 1891 to a continuous revetment. This has been repaired, as occasion required, and extended from year to year until the work has now a length of about 14,500 feet, in good order, except some repairs which could not be completed during the past working season for lack of time and plant.

Lake Providence revetment, 540 miles below Cairo, right bank.—This improvement, together with those at Ashbrook Neck and Greenville Harbor, before mentioned, is illustrative of three important classes of work to which bank protection is applicable. At Ashbrook Neck a cut-off has been prevented, which, if allowed, would have so changed the course of the river in the vicinity that two other cut-offs would have inevitably followed, together with an increase of caving and the destruction of a considerable part of the levee system of the Yazoo and Tensas basins.

The bank protection at Greenville has saved the most important trading and railroad center of the Yazoo Basin.

At Lake Providence the river threatened to cave through the levee into an old cut-off lake. The bank has been successfully protected by revetment in order to maintain the present levee and prevent the necessity of a new one around the lake. As this would have been many miles in length and included the damming of the Tensas River and Baxters Bayou, the present work is of great importance. It was commenced in 1890; it has a length of about 11,000 feet, and, with slight exceptions, is in good order. Its extension upstream to cover that part of the bank which is still caving is of importance.

Delta Point, 598 miles below Cairo, right bank.—This is still another illustration of the useful application of bank protection. The Vicksburg cut-off of 1876 promptly removed the harbor some miles from the city front. The distance to which it was removed was limited by the resistance of Delta Point, and it was of great importance that any further recession should be prevented. Revetment was commenced

in 1878, and since that time the point has been held, thus maintaining a condition under which the improvement, if not the restoration, of the harbor is possible. Considerable repairs were made during the past season, and it is now necessary that an upstream extension should be made as soon as funds can be provided. Reference is invited to the report of Capt. C. L. Potter, executive officer of the district, and to the reports of his assistant engineers for full description of the work in this part of the river, and for details of the season's work (Appendix 4).

Fourth district, from Warrenton, Miss., to the Head of the Passes, 453 miles.—Office 3232 Prytania street, New Orleans, La.; district officer, Maj. Geo. McC. Derby, Corps of Engineers, U. S. A.

Improvements in this district have been conducted at the following localities: Kempe Bend, Natchez and Vidalia Harbor, the junction of the Mississippi, Red, and Atchafalaya rivers, and New Orleans Harbor.

Kempe Bend, 658 miles below Cairo, right bank.—The levee along this bend follows the narrow remaining strip of high ground between the river and a swamp of unusual depth and area. Both the levee and its location are closely threatened by caving. If lost, the continuity of the levee protecting the Tensas Basin could only be restored by building a line around the swamp, at a cost considerably exceeding $500,000. It is doubtful if this could be done in a single season. The situation is in many respects similar to that at Lake Providence, in the third district, before described. For the reasons given, it was decided by the Commission to protect the bank by a revetment. This was commenced as soon in the season as the river conditions would permit, and before work was stopped by high water upward of 4,000 linear feet were completed. It is quite evident that it is a case of emergency to extend the revetment both up and down stream during the coming season.

Owing to the remoteness of any stone supply from the works of improvement in this district, the cost of this necessary part of the material for bank protection has always been excessive. Extensive experiments have therefore been conducted by the district officer here and at Giles Bend, to be mentioned hereafter, to substitute concrete or brick. The observed results are encouraging, but conclusions can not be reached until a low-water season has passed. The work is now in good condition.

Natchez (Miss.) and Vidalia (La.) Harbor, 700 miles below Cairo.—The preservation of this harbor is dependent upon the prevention of a cut-off through a long and narrow point immediately above, by the revetment of Giles Bend, on its upper side. Work here has been in progress for three years. It was first expected that a series of spurs, such as had proved successful at certain points below Red River, would be sufficient, but it subsequently proved necessary, from the violence of the local conditions, to connect them with revetment mats. The work, although including much of the experimental construction before mentioned, appears in good order, but a considerable downstream extension is required.

The junction of the Mississippi, Red, and Atchafalaya rivers, 764 miles below Cairo, right bank.—No work has been necessary at this point, which in former years has presented such great obstruction to navigation, except intermittent dredging for the four low-water months,

August to November, inclusive. Without some change in the favorable conditions which have prevailed for some years, no work is anticipated here except the repair and strengthening of the dams for the prevention of the enlargement of the Atchafalaya River and the continuance of dredging in lower Old River. These, however, are so important that funds should always be available for these works.

New Orleans Harbor, 963 miles below Cairo.—This harbor includes both banks of the river, with an aggregate length of upward of 30 miles. In consequence of the extent of the work and the inadequacy of appropriations many parts of the commercial front are in a very critical condition, and extensive caving, involving the loss of structures valuable both from their cost and their commercial service, is apprehended. This is particularly true of the terminal of the Illinois Central Railroad, known as South Port, where extensive trackage, wharves, warehouses, and elevators have been built. So great is the emergency at some points that the Commission has felt compelled to apply bank protection first to localities where the greatest danger existed or where the largest interests were located, instead of pursuing the work systematically from above downstream, thus transmitting the result of permanence gained above to each successive concave bend below. No work was done during the past season, owing to deficiency of plant. Such work as had been done in previous years is generally in good condition.

Fuller description of the conditions existing at the several works of improvement in this district and details of the season's work will be found in the report of Maj. Geo. McC. Derby, and in those of his assistant engineers (Appendix 5), to which attention is invited.

LEVEES.

The general allotment for levees from the appropriation in the sundry civil act of 1899 was subdivided as follows:

Upper St. Francis Levee district	$20,000
Lower St. Francis Levee district	123,500
White River Levee district	61,750
Upper Yazoo Levee district	123,500
Lower Yazoo Levee district	247,000
Upper Tensas Levee district	197,600
Lower Tensas Levee district	217,300
Atchafalaya Levee district	98,800
Lafourche Levee district	37,050
Pontchartrain Levee district	74,100
Barataria Levee district	24,700
Lake Borgne Levee district	24,700

In the annual report of the Commission for 1899 a full description of the levee basins and of the levees in the several districts was given. It is unnecessary at this time to repeat this, and reference is made to that report, contained, as Appendix W W, in the Annual Report of the Chief of Engineers for that year, pages 3319–3326.

As regards the levees, the year has been uneventful. With favorable weather, reasonable prices, and the absence of high water, very satisfactory progress has been made. Although neither the levees of any district, nor of any considerable part of a district, have as yet been given the grade or cross section which is thought necessary by the Commission, yet the work as it stands—over 1,300 miles long—is

in greatly improved condition. Each of the district lines is continuous, with the following exceptions: Work was not commenced by the United States in the Upper St. Francis Basin until 1899, and only 3 miles out of 70 are built. In the Lower St. Francis Basin 161 miles out of 207 are built. There also exists a small gap in the town of Point Pleasant, owing to the failure of the local authorities to provide the right of way which is required in all cases by the Commission. In the Upper Tensas district an extension remains to be made of the line below Lake Jefferson, overlapping the Amos Bayou Levee. The lower end of the Lower Tensas line needs an extension of about 10 miles to cover the Bougere Bend.

The reports of the district officers and their assistant engineers are very full concerning the levees in their charge, and reference is invited thereto. Under these circumstances it is thought that the necessary information on the subject can be best given in tabular form.

Tabulated statement of condition of levees and of work of year ending June 30, 1900.

District.	Length.	Contents in 1899.	Built since by United States.	Built since by local authorities.	Total constructed.
	Miles.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*
Upper St. Francis	85	.....	135,544	.....	135,544
Lower St. Francis	207	7,409,908	661,591	3,651,680	11,723,179
White River	64	6,574,798	210,214	218,280	7,003,292
Upper Yazoo	124	15,671,281	610,334	422,617	16,704,232
Lower Yazoo	188.14	25,913,650	1,850,200	1,068,576	28,832,426
Upper Tensas	171.66	24,447,355	1,553,373	784,882	26,785,610
Lower Tensas	131.5	15,227,072	1,264,649	449,323	16,941,044
Atchafalaya	122	16,527,388	646,005	958,476	18,131,869
Lafourche	78	6,868,722	272,919	261,251	7,402,892
Barataria	71.5	2,456,027	292,685	61,698	2,810,410
Pontchartrain	123.5	12,443,772	466,140	64,237	12,974,149
Lake Borgne	70	2,834,748	233,233	160,861	3,228,837
Total	1,496.3	136,374,716	8,196,887	8,101,881	152,673,484

District.	Loss.	Contents in 1900.	Required to complete.	Final contents.	Percentage built.
	Cubic yards.	*Cubic yards.*	*Cubic yards.*	*Cubic yards.*	
Upper St. Francis	.....	135,544	7,000,000	7,135,544	0.019
Lower St. Francis	.....	11,723,179	12,500,000	24,223,179	.484
White River	.....	7,003,292	9,600,000	16,603,292	.422
Upper Yazoo	.....	16,704,232	10,300,000	27,004,232	.619
Lower Yazoo	.....	28,832,426	17,845,000	46,677,426	.618
Upper Tensas	.....	26,785,610	18,542,876	45,328,486	.591
Lower Tensas	1,216,025	15,725,019	13,106,053	28,831,072	.545
Atchafalaya	394,200	17,737,669	7,013,719	24,751,388	.716
Lafourche	211,000	7,191,892	3,596,830	10,788,722	.667
Barataria	65,100	2,745,310	1,660,717	4,406,027	.623
Pontchartrain	.....	12,974,149	6,064,623	19,038,772	.681
Lake Borgne	192,000	3,036,837	1,861,906	4,898,743	.620
Total	2,078,325	150,595,159	109,091,724	259,686,883	.579

Records have been kept with sufficient accuracy for the past four years to allow a preliminary computation of the losses of levee by crevasses, caving, or other causes, on which can be based an estimate of the cost of maintenance of the levee system. During this limited period the annual average loss is 2¼ per cent of the existing levees. While, on the one hand, the considerable length of new levees on good locations would tend to decrease this, it should be remembered that there yet remain great lengths of old levees close to caving banks, and that the many crevasses in the great flood of 1897 are included in the

estimate. Both of these circumstances would tend to increase the rate of loss. It is probably about fair, although continued observation is required to substantiate it. But the loss of a given length of levee by caving can only be restored by the building of a loop of a greater length inclosing the gap. Assuming this increase of length and contents at 50 per cent places the cost of the maintenance of the levee system, with such grades, sections, and locations as are now usual, at less than 3½ per cent of its construction. It is probable that this will not be exceeded when the system approaches completion in locations, construction, and dimensions.

For the past eighteen years the United States and the levee organizations of the several riparian States—Missouri, Arkansas, Mississippi, and Louisiana—have cooperated in the improvement of the levees of the Mississippi River. An effort has been made during the year to ascertain the relative contributions by the several parties. This has not been done without difficulty, owing to imperfect records, to the free contributions of materials and labor, to frequent changes in the subdivisions of the districts, to the want of coincidence in the United States and State districts and fiscal years, and to the different items which are included in the different statements. It can not, therefore, be assumed that the following statements are absolutely correct, but the information they contain is of interest. In the case of State work, it is given in the form adopted by the several State or levee district engineers.

It should be remembered that when the United States first extended assistance in the building of levees for the improvement of navigation and the prevention of destructive floods there already existed a levee system protecting the alluvial lands of Louisiana, Mississippi, and the greater part of Arkansas below the St. Francis River, which had been built by local organizations and private parties, partly with the proceeds of the swamp-land grant by the United States in 1850. Although this never attained the dimensions necessary for complete security, it was a work of great magnitude. This is not included in the following statements, which begin with 1882, when the first levee allotment was made by the Commission.

The information received from Missouri, the White River Basin in Arkansas, and from that part of the same State in the Tensas Basin, is so incomplete that its insertion in the table would be misleading. It has also been impossible to obtain the exact annual yardage built by the United States, or the annual division of amounts.

Levee expenditure by United States from 1882 to April 30, 1900.

District.	Cost.
Upper St. Francis	$19,691.22
Lower St. Francis	610,393.95
White River	1,121,257.08
Upper Yazoo	1,055,105.93
Lower Yazoo	2,792,834.95
Upper Tensas	3,946,710.56
Lower Tensas	2,296,583.84
Atchafalaya	1,290,643.08
Lafourche	487,070.91
Barataria	311,660.04
Pontchartrain	992,583.06
Lake Borgne	269,515.57
Total	15,193,050.21

In the sums entered in this table are included field and office and high-water expenses, but none for right of way. The Commission has always insisted that the latter should be granted free. This is done in Louisiana by the constitution of the State, and elsewhere by purchase by the local authorities.

Levee construction done by the St. Francis Levee boards of Arkansas and Missouri since organization in 1893.

[Statement prepared by chief engineer St. Francis Levee board, April 14, 1900.]

Year.	Cubic yards.	Cost.
1893–94	728,928	$100,781.88
1894–95	1,870,243	244,884.69
1895–96	227,631	21,675.57
1896–97	203,872	30,580.39
1897–98	707,517	86,460.06
1898–99	125,110	17,752.98
1899–1900	3,651,680	606,522.07
Total	7,009,976	1,378,757.64

The above includes the present fiscal year, and includes right of way, engineering, and other expenses. This table sufficiently explains the items included.

Statement showing total yardage and cost of all work done by the Yazoo-Mississippi Delta Levee district from May, 1884, to May 1, 1900, not including cubic yards in canals, drainage ditches, etc., not directly connected with levee construction, nor cubic yards done by repair force and by other forces as high-water work.

Date.	Cubic yards.	Construction.	Levee maintenance.	All other expenditures.
1884–85	2,000,047	$498,934.50	$2,087.28	$61,347.05
1885–86	816,090	61,890.68	1,206.69	117,559.13
1886–87	1,662,130	379,961.35	3,604.79	102,302.29
1887–88	91,789	19,549.18	5,245.94	105,320.92
1888–89	461,509	101,543.41	2,906.98	84,133.66
1889–90	273,596	49,342.23	5,739.40	116,513.88
1890–91	582,164	124,141.37	14,570.00	88,562.62
1891–92	538,894	102,122.74	16,357.70	62,182.00
1892–93	439,106	97,399.35	13,568.38	180,148.68
1893–94	299,147	42,111.68	20,410.10	82,547.34
1894–95	460,143	87,879.78	11,960.84	69,350.36
1895–96	901,078	94,797.83	13,224.12	62,903.66
1896–97	828,898	98,772.45	9,312.44	267,009.77
1897–98	2,935,484	485,812.56	35,594.34	157,538.14
1898–99	736,732	108,719.67	39,228.98	114,996.62
1899–1900	850,131 a 108,095	149,705.77 b 168.45	19,957.91	105,982.61
Total	13,480,022	2,496,852.90	214,924.89	1,768,338.78

a Done by repair force of which record was kept. b Haul-over on United States work.

SUMMARY.

Construction	$2,496,852.90
Levee maintenance	214,924.89
All other expenditures	1,768,338.73
Total	4,480,116.52

This table clearly defines the terms included.

Work done and money expended by the board of Mississippi levee commissioners (Lower Yazoo district) from July 1, 1882, to May 1, 1900.

[Statement prepared by chief engineer Mississippi Levee district.]

Year.	Earth-work embankment and muck ditch.	Timber work.	Cost of earth and timber work.	Paid out on Government work, yardage for which is included in their statements.	Engineering expenses.	High-water protection.	
						Year.	Cost.
	Cu. yds.	*Ft. B. M.*					
July 1, 1882, to July 1, 1883 ...	632,083	.....	$196,423.12	.....	$7,871.60	1882	$59,212.75
July 1, 1883, to July 1, 1884 ...	725,197	.....	195,303.30	.....	8,555.12	1883	19,628.96
July 1, 1884, to July 1, 1885 ...	500,847	151,500	117,144.96	.....	6,696.77	1884	30,921.11
July 1, 1885, to July 1, 1886 ...	727,070	.....	145,925.47	.....	7,644.89	1885	4,796.94
July 1, 1886, to July 1, 1887 ...	878,232	195,832	163,043.43	.....	8,573.21	1886	5,493.67
July 1, 1887, to July 1, 1888 ...	1,753,397	105,782	416,299.68	.....	11,265.94	1887	4,796.08
July 1, 1888, to July 1, 1889 ...	576,359	.....	139,156.77	.....	8,138.09	1888	.....
July 1, 1889, to July 1, 1890 ...	779,940	67,000	128,859.09	.....	11,724.56	1889	1,539.58
July 1, 1890, to July 1, 1891 ...	1,657,105	259,741	353,774.56	.....	11,634.05	1890	134,107.60
July 1, 1891, to July 1, 1892 ...	1,609,460	.....	411,751.43	$1,773.02	13,329.23	1891	41,668.46
July 1, 1892, to July 1, 1893 ...	1,967,316	148,589	417,896.34	.....	10,636.77	1892	35,817.92
July 1, 1893, to July 1, 1894 ...	628,837	.....	127,037.81	.....	6,386.68	1893	14,759.22
July 1, 1894, to July 1, 1895 ...	269,670	.....	37,494.21	.....	5,335.85	1894	382.58
July 1, 1895, to July 1, 1896 ...	806,432	.....	84,719.07	.....	6,444.51	1895	120.00
July 1, 1896, to July 1, 1897 ...	1,228,314	.....	152,698.73	70.00	6,904.48	1896	28.85
July 1, 1897, to July 1, 1898 ...	253,289	.....	40,820.92	48,567.74	5,230.25	1897	96,170.39
July 1, 1898, to July 1, 1899 ...	789,473	.....	126,935.78	3,135.88	7,308.68	1898	96,464.96
July 1, 1899, to May 1, 1900 ...	966,950	.....	156,995.23	3,878.56	6,145.61	1899	4,236.16
Total	17,049,971	928,444	3,412,282.90	57,425.20	149,821.29	.....	550,145.23

Year.	Cost of rights of way.	Paid interest and coupons.	Officers' salaries, expenses, mileage, and per diem.	Guarding and maintenance of levee.	Total expenditures for each year.	Remarks.
1882.....	$23,647.04	$3,392.78	$7,137.67	$3,770.54	$301,455.50	$200,000 of 10 per cent bonds issued from May, 1882, to December, 1883. These bonds were paid from December, 1885, to December, 1890.
1883.....	10,200.80	25,186.83	7,642.01	5,646.24	272,168.26	
1884.....	10,091.24	23,512.20	8,371.11	372.55	197,109.94	
1885.....	11,678.36	29,440.05	7,356.25	.....	206,841.96	
1886.....	20,796.20	20,599.30	8,843.34	.....	227,349.15	
1887.....	84,111.47	24,090.91	8,957.93	.....	499,522.01	$250,000 of 6 per cent bonds issued, refunded with 5 per cent bonds March, 1899.
1888.....	23,535.98	28,133.40	9,345.20	.....	208,309.44	
1889.....	4,725.42	18,925.82	8,267.54	.....	174,042.01	
1890.....	65,353.60	35,821.88	11,720.14	.....	612,411.83	$200,000 of 6 per cent bonds issued, refunded with 5 per cent bonds March, 1899.
1891.....	66,139.62	46,208.71	9,063.69	.....	589,957.16	$500,000 of 6 per cent bonds issued, now outstanding.
1892.....	53,770.66	56,179.20	9,274.44	.....	583,575.33	Future revenue anticipated by issue of engineers' certificates.
1893.....	23,727.51	75,593.14	8,216.51	1,495.33	257,216.20	
1894.....	30,708.49	62,890.15	8,690.90	252.67	145,749.85	$200,000 of 6 per cent bonds issued to take up outstanding engineers' certificates. These bonds are now outstanding.
1895.....	25,125.13	77,909.32	8,110.22	254.82	202,683.07	
1896.....	16,906.11	67,198.59	8,082.15	726.25	252,615.16	
1897.....	95,823.35	75,457.06	10,769.74	1,987.79	374,777.24	Extraordinary rights of way due to Huntington Short Line and several other new levees, one of which was in Greenville.
1898.....	54,363.27	75,682.36	11,267.27	2,348.15	377,501.85	
1899.....	22,338.38	58,427.30	10,730.71	1,687.65	264,389.60	
Total ..	598,087.63	804,649.00	161,866.82	18,441.99	5,747,670.06	

This table needs no explanation.

Quantity and cost of levee work done by the State of Louisiana and its several district levee boards, on the Mississippi River, from April 20, 1882, to April 20, 1900, by periods of two years, in each of the United States levee districts.

[Statement prepared by the Board of State Engineers of Louisiana, April 20, 1900, by request, for the information of the Mississippi River Commission.]

NOTE.—These tables do not include the large and mostly unrecorded amount of work done on public levees in Louisiana by parochial and municipal authorities, by corporations and private parties, and do not include any expenses of administration or discount or interest paid by the several levee districts on bonds or other debts. They are also exclusive of most of the wooden revetments and other protective works, and of high-water expenses, such as sacks, lumber, freight, guards, laborers, etc.

Name of United States levee districts.	1882 to 1884.		1884 to 1886.		1886 to 1888.	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Upper Tensas	668,649	$161,170.90	598,644	$146,201.69	1,844,953	$413,454.36
Lower Tensas	376,567	93,805.69	229,077	64,488.69	1,192,770	298,968.66
Atchafalaya Basin	563,131	146,956.06	577,182	125,658.67	712,630	151,655.34
Lafourche	315,723	70,425.02	406,767	84,539.34	368,736	58,644.90
Barataria	128,418	31,212.20	64,288	11,298.27	129,532	18,925.60
Pontchartrain	609,197	159,548.04	437,374	88,578.60	544,884	85,702.40
Lake Borgne	139,934	30,374.85	57,153	9,522.34	50,540	6,719.54
Total	2,801,619	696,488.76	2,434,485	580,287.60	4,784,045	1,034,170.80

Name of United States levee districts.	1888 to 1890.		1890 to 1892.		1892 to 1894.	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Upper Tensas	2,396,248	$402,460.17	1,758,211	$408,087.86	2,150,850	$378,338.56
Lower Tensas	319,468	54,796.62	635,425	114,002.51	119,607	24,929.16
Atchafalaya Basin	1,513,368	233,835.58	3,226,319	749,359.95	1,199,913	220,585.34
Lafourche	524,192	75,914.68	616,981	116,724.73	1,789,489	281,250.27
Barataria	166,620	24,225.79	591,005	100,918.70	998,041	80,454.96
Pontchartrain	706,992	102,325.74	1,299,739	245,410.20	1,594,582	444,656.86
Lake Borgne	253,706	34,702.96	876,945	160,033.07	520,001	87,948.77
Total	5,880,594	928,261.54	8,969,575	1,889,587.02	7,772,483	1,518,163.92

Name of United States levee districts.	1894 to 1896.		1896 to 1898.		1898 to 1900.	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Upper Tensas	567,024	$76,860.35	253,909	$43,150.79	1,757,014	$289,414.12
Lower Tensas	789,374	108,925.56	1,667,561	241,354.81	504,246	101,396.45
Atchafalaya Basin	518,215	68,407.65	1,868,205	250,942.96	1,694,441	285,670.81
Lafourche	21,542	2,195.20	449,085	74,560.48	473,292	71,971.89
Barataria	112,334	16,359.84	492,114	91,218.15	116,791	17,941.83
Pontchartrain	297,841	41,650.39	299,069	49,382.10	252,284	51,662.24
Lake Borgne	137,216	22,071.82	379,554	67,193.37	377,123	54,635.94
Total	2,443,546	336,470.81	5,409,497	817,802.66	5,175,191	872,693.28

Quantity and cost of levee work done by the State of Louisiana and its several district levee boards on the Mississippi River, etc.—Continued.

RECAPITULATION FROM APRIL 20, 1882, TO APRIL 20, 1900.

Name of United States levee districts.	1882 to 1892.		1892 to 1900.		Totals, 1882 to 1900.	
	Cubic yards.	Cost.	Cubic yards.	Cost.	Cubic yards.	Cost.
Upper Tensas	7,261,705	a$1,526,374.98	4,728,797	d$787.763.82	11,990,502	g$2,314,138.80
Lower Tensas	2,753,807	626,062.17	3,080,788	476,605.98	5,834,095	1,102,668.15
Atchafalaya Basin	6,792,630	1,407,461.60	5,280,774	825,606.76	11,873,404	2,233,068.36
Lafourche	2,232,349	406,248.67	2,733,408	429,977.84	4,965,748	836,226.51
Barataria	1,979,863	b186,580.56	1,119,280	e205,974.78	2,199,143	h392,555.34
Pontchartrain	4,568,186	681,564.98	2,443,776	587,351.59	6,011,962	1,268,916.57
Lake Borgne	1,378,278	c241,402.76	1,413,894	f231,849.90	2,792,172	i473,302.66
Total	24,866,318	5,075,745.72	20,800,717	3,545,130.67	45,667,026	8,620,876.39

a Includes 1,152,417 cubic yards, costing $287,676.68, in State of Arkansas.
b Includes 71,241 cubic yards, costing $13,715.69, in Orleans Parish, right bank.
c Includes 384,011 cubic yards, costing $83,057.70, in Orleans Parish, left bank.
d Includes 1,049,292 cubic yards, costing $177,241.89, in State of Arkansas.
e Includes 651,062 cubic yards, costing $130,315.51, in Orleans Parish, right bank.
f Includes 445,845 cubic yards, costing $86,892.67, in Orleans Parish, left bank.
g Includes 2,201,709 cubic yards, costing $464,918.57, in State of Arkansas.
h Includes 722,303 cubic yards, costing $144,031.20, in Orleans Parish, right bank.
i Includes 829,856 cubic yards, costing $169,950.37, in Orleans Parish, left bank.

The explanatory note accompanying the preceding table gives the items included. The right of way for levees is free in this State. Expenses of administration and high-water expenses are omitted. It should be added that the State has exclusive charge of levees on the Red, Ouachita, Atchafalaya, Des Glaizes, and Lafourche, aggregating 545.2 miles in length. By a recent act of the legislature the locking of Bayou Lafourche at Donaldsonville has been authorized, at the cost of the interested levee districts, in order to enable them to apply the revenues now used in maintaining the levees of the bayou to those on the Mississippi River, in cooperation with this Commission.

CONDITIONS DURING THE YEAR.

The year since the last report has passed without extremely low water and with a flood stage lower than the average. The conditions for work have generally been good. A table is added giving the highest and lowest readings for the year at the several gauges and the differences as compared with the extreme record.

Highest and lowest stages in previous years and in 1900.

Gauge station.	Highest.	High, 1900.	Difference.	Lowest.	Low, 1899.	Difference.
Cairo	52.17	39.2	12.97	−1.00	2.98	3.98
Belmont	45.55	36.9	8.65	.05	2.97	2.92
New Madrid	40.27	32.0	8.27	.55	2.60	2.05
Cottonwood	39.35	31.4	7.95	−3.35	− .20	3.15
Fulton	38.30	28.1	10.20	.16	2.63	2.47
Memphis	37.66	29.6	8.06	−2.65	.54	3.19
Mhoon	41.60	32.5	9.10	−7.80	−4.80	3.00
Helena	51.75	38.2	13.55	−3.00	1.70	4.70
Sunflower	41.17	37.1	4.07	−1.50	2.76	4.26
White River	52.42	40.8	11.62	.00	4.70	4.70
Arkansas City	51.90	39.3	12.60	−3.60	1.00	4.60
Greenville	46.75	33.8	12.95	−2.55	1.20	3.75
Lake Providence	44.54	33.0	11.54	−5.30	−2.15	3.15
Vicksburg	52.48	38.0	14.48	−6.50	−1.58	4.92
St. Joseph	47.85	33.7	14.15	−9.30	−5.20	4.10
Natchez	49.82	37.0	12.82	− .85	2.60	3.45
Red River	50.20	36.3	13.90	− .60	1.00	1.60
Bayou Sara	43.70	29.1	14.60	−2.70	- 1.40	1.30
Baton Rouge	40.65	27.2	13.45	.45	1.20	.75
Plaquemine	36.25	23.8	12.45	− .94	.04	.98
Donaldsonville	32.75	21.8	10.95	1.00	2.15	1.15
College Point	27.95	18.3	9.65	− .91	− .39	.52
Carrollton	19.17	12.6	6.57	−1.60	.00	1.60
Fort Jackson	7.20	5.9	1.30	.30	.88	.58

The estimates which follow cover the amounts which, in the judgment of the Commission, can be advantageously expended during the fiscal year ending June 30, 1902. For the reasons set forth in this report, the Commission is of the opinion that it will be greatly to the advantage of the work that the sum mentioned for the general improvement of the Mississippi River from the Head of the Passes to the mouth of the Ohio River ($3,000,000) should be embodied in a continuous appropriation of that sum annually for six years, and it is earnestly so recommended.

Respectfully submitted.

G. L. GILLESPIE,
Colonel, Corps of Engineers, U. S. A.,
President Mississippi River Commission.
B. M. HARROD.
R. S. TAYLOR.
AMOS STICKNEY,
Lieut. Col., Corps of Engineers, U. S. A.
THOS. H. HANDBURY,
Major, Corps of Engineers, U. S. A.
HENRY L. MARINDIN,
Assistant, U. S. Coast and Geodetic Survey.
J. A. OCKERSON.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Money statement.

Appropriations expended under Mississippi River Commission.

July 1, 1899, balance unexpended		$4,380,499.62
Amount appropriated by sundry civil act of June 6, 1900		2,250,000.00
		6,630,499.62
June 30, 1900, amount expended during fiscal year		2,990,586.79
July 1, 1900, balance unexpended		3,639,912.83
July 1, 1900, outstanding liabilities	$57.818.23	
July 1, 1900, amount covered by uncompleted contracts	531,873.30	
		589.691.53
July 1, 1900, balance available		3,050,221.30
Distributed as follows:		
Mississippi River Commission		14,478.36
Surveys, gauges, and observations		71,811.09
Levees		111,306.96
Revetment and contraction works, permanent channel improvements and protection		38,483.47
Dredges and dredging		221,479.38
Experimental dikes		21,160.68
Plant and miscellaneous		403.32
Improving harbors and tributaries		273,248.04
Works above Cairo		7,361.00
Unallotted		2,290,489.00
		3,050,221.30

Amounts necessary to be appropriated for the fiscal year ending June 30, 1902.

For continuing the improvement of the Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission	$3,000,000
Improving harbor at New Madrid, Mo	20,000
Protection of banks at or near Caruthersville, Mo	50,000
Improving harbor at Memphis, Tenn	100,000
Improving harbor at Memphis, Tenn. (at Wolf River)	30,000
Improving harbor at Helena, Ark	20,000
Improving harbor at Greenville, Miss	50,000
Protection of banks at Delta Point, Louisiana	120,000
Improving harbor at Natchez, Miss., and Vidalia, La	150,000
Rectification of Red and Atchafalaya rivers, Louisiana	50,000
Improving harbor at New Orleans, La	300,000
	3,890,000

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1900.

[Appropriation: Improving Mississippi River.]

SECRETARY MISSISSIPPI RIVER COMMISSION.

	Improving Mississippi River.					
	Mississippi River Commission.	Surveys gauges, and observations.	Experimental dikes.	Dredges and dredging.	Patrol of the Mississippi River.	Total.
Amount expended on previous projects	$288,110.74	$855,247.37	.....	.....	.....	$1,093,358.11
Amount expended on present project to end of last fiscal year.	308,983.56	619,978.69	a $216.45	b $1,182,066.29	$1,055.56	2,112,300.55
Balance unexpended at end of last fiscal year	49,016.44	145,456.64	65,854.57	1,004,628.01	.....	1,264,955.66
Amount appropriated or allotted since (net)	.....	.....	.....	.....	.....	.....
	49,016.44	145,456.64	65,854.57	1,004,628.01	.....	1,264,955.66
Amount expended from beginning of present fiscal year to end of previous month	31,317.16	68,121.46	44,686.98	446,158.92	.....	585,284.52
Amount expended during the month	801.68	6,358.54	6.41	9,720.31	.....	16,886.94
	32,118.84	69,480.00	44,693.39	455,879.23	.....	602,171.46
Balance unexpended at end of month	16,897.60	75,976.64	21,161.18	548,748.78	.....	662,784.20
In Treasury United States	10,289.40	63,458.16	17,000.00	501,972.10	.....	592,719.66
In hand	6,608.20	12,518.48	4,161.18	46,776.68	.....	70,064.54
	16,897.60	75,976.64	21,161.18	548,748.78	.....	662,784.20
Outstanding liabilities at end of month	2,419.24	7,445.51	.50	17,333.52	.....	27,198.77
Amount covered by existing contracts at end of month	.....	.....	.....	309,935.88	.....	309,935.88
	2,419.24	7,445.51	.50	327,269.40	.....	337,134.65
Balance available at end of month	14,478.36	68,531.13	21,160.68	221,479.38	.....	325,649.55

a Does not include $8,928.98 expended by officer in charge of first and second districts.
b Does not include $388,097.12 expended by officer in charge of first and second districts. Does not include $2,506.99 expended by officer in charge of fourth district.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1900—Continued.

WORKS ABOVE CAIRO.

	Protection near Cairo.a	Des Moines Rapids to Ohio River.	Total.
Amount expended on previous projects			
Amount expended on present project to end of last fiscal year	$42,600.00	$687,632.58	$730,232.52
Balance unexpended at end of last fiscal year	7,400.00		7,400.00
Amount appropriated or allotted since (net)			
	7,400.00		7,400.00
Amount expended from beginning of present fiscal year to end of previous month			
Amount expended during the month			
Balance unexpended at end of month	7,400.00		7,400.00
In Treasury United States	7,400.00		7,400.00
In hand			
	7,400.00		7,400.00
Outstanding liabilities at end of month	39.00		39.00
Amount covered by existing contracts at end of month			
	39.00		39.00
Balance available at end of month	7,361.00		7,361.00

a Includes only work under act of July 5, 1884.

FIRST AND SECOND DISTRICTS.

[Appropriations: Improving Mississippi River; improving harbor at Memphis, Tenn.]

	Improving Mississippi River.				
	Surveys, gauges, and observations.	Upper St. Francis Levee district.	Lower St. Francis Levee district.	White River Levee district.	Upper Yazoo Levee district.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	$94,172.85		$463,474.55	$1,071,528.51	$955,340.08
Balance unexpended at end of last fiscal year	5,000.76	$20,000.00	129,652.45	64,206.09	123,511.70
Amount appropriated or allotted since (net)					
	5,000.76	20,000.00	129,652.45	64,206.09	123,511.70
Amount expended from beginning of present fiscal year to end of previous month	3,553.83	19,691.22	118,755.99	49,728.57	99,765.85
Amount expended during the month	90.00		491.26	787.00	516.43
	3,643.83	19,691.22	119,247.25	50,515.57	100,282.28
Balance unexpended at end of month	1,356.93	308.78	10,405.20	13,690.52	23,229.42
In Treasury United States			10,000.00	10,000.00	15,000.00
In hand	1,356.93	308.78	405.20	3,690.52	8,229.42
	1,356.93	308.78	10,405.20	13,690.52	23,229.42
Outstanding liabilities at end of month			250.00	200.00	108.26
Amount covered by existing contracts at end of month				10,587.98	15,600.00
			250.00	10,787.98	15,708.26
Balance available at end of month	1,356.93	308.78	10,155.20	2,902.59	7,521.16

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1900—Continued.

FIRST AND SECOND DISTRICTS—Continued.

	Improving Mississippi River.				
	Walnut Bend Levee (preservation of works at).	Plum Point Reach.	Plant.	At Hickman, Ky.	At New Madrid, Mo.
Amount expended on previous projects	.....	.....	.....	.....	.....
Amount expended on present project to end of last fiscal year	$28,143.41	$4,890,587.82	$782,864.87	$89,132.00	$111,561.25
Balance unexpended at end of last fiscal year	1,856.59	78,123.30	27,835.11	6,000.00	40,438.75
Amount appropriated or allotted since (net)	.....	8,000.00	.....	.....	.....
	1,856.59	86,123.30	27,835.11	6,000.00	40,438.75
Amount expended from beginning of present fiscal year to end of previous month	.....	86,004.02	25,955.50	2,853.56	36,015.69
Amount expended during the month	.....	1.25	1,426.29	83.33	27.17
	.....	86,005.27	27,381.79	2,936.89	36,042.86
Balance unexpended at end of month	1,856.59	118.03	453.32	3,063.11	4,395.89
In Treasury United States	.....	.....	.....	2,000.00	.....
In hand	1,856.59	118.03	453.32	1,063.11	4,395.89
	1,856.59	118.03	453.32	3,063.11	4,395.89
Outstanding liabilities at end of month	.....	.....	50.00	200.00	.....
Amount covered by existing contracts at end of month	.....	.....	.....	.....	.....
	.....	.....	50.00	200.00	.....
Balance available at end of month	1,856.59	118.03	403.32	2,863.11	4,395.89

	Improving Mississippi River.					
	Carutherville, Mo.	Hopefield Bend (preservation of works at).	At Memphis, Tenn.	At Helena, Ark.	Expended allotments.	Total.
Amount expended on previous projects	.....	.....	.....	.....	.....	.....
Amount expended on present project to end of last fiscal year	$17,490.04	$18,595.72	$82,324.85	$170,477.84	a$579,643.99	$9,255,286.78
Balance unexpended at end of last fiscal year	37,509.96	61,404.28	12,675.15	30,022.16	.....	638,236.30
Amount appropriated or allotted since (net)	.....	.....	.....	.....	.....	8,000.00
	37,509.96	61,404.28	12,675.15	30,022.16	.....	646,236.30
Amount expended from beginning of present fiscal year to end of previous month	36,433.57	59,759.02	4,392.81	26,979.72	.....	569,889.85
Amount expended during ing the month	.....	223.57	.....	.....	.....	3,646.80
	36,433.57	59,982.59	4,392.81	26,979.72	.....	573,535.65
Balance unexpended at end of month	1,076.39	1,421.69	8,282.34	3,042.44	.....	72,700.65
In Treasury United States	.....	.....	3,000.00	.....	.....	40,000.00
In hand	1,076.39	1,421.69	5,282.34	3,042.44	.....	32,700.65
	1,076.39	1,421.69	8,282.34	3,042.44	.....	72,700.65

a Preservation of works, $54,867.89; removal of Nonconnah Rock, $9,000; dredges and dredging, $388,097.12; experimental dikes, $8,928.98; Columbus, Ky., $43,750; improving St. Francis River, $75,000.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1900—Continued.

FIRST AND SECOND DISTRICTS—Continued.

	Improving Mississippi River.					
	Caruthersville, Mo.	Hopefield Bend (preservation of works at).	At Memphis, Tenn.	At Helena, Ark.	Expended allotments.	Total.
Outstanding liabilities at end of month	$200.00	.....	$100.00	$100.00	.....	$1,208.26
Amount covered by existing contracts at end of month	.....	.....	.....	.....	.....	26,187.93
	200.00	.....	100.00	100.00	.....	27,396.19
Balance available at end of month	876.39	$1,421.69	8,182.34	2,942.44	.....	45,304.46

	Improving harbor at Memphis, Tenn.		Grand total.
	Improving harbor at Memphis, Tenn.	Improving harbor at Memphis, Tenn. (Wolf River).	
Amount expended on previous projects	.....	.....	.....
Amount expended on present project to end of last fiscal year	$1,425,038.77	$25,070.03	$10,705,395.58
Balance unexpended at end of last fiscal year	.....	19,929.97	658,166.27
Amount appropriated or allotted since (net)	.....	.....	8,000.00
	.....	19,929.97	666,166.27
Amount expended from beginning of present fiscal year to end of previous month	.....	5,520.48	575,409.83
Amount expended during the month	.....	2,923.87	6,570.17
	.....	8,444.35	581,980.00
Balance unexpended at end of month	.....	11,485.62	84,186.27
In Treasury United States	.....	10,000.00	50,000.00
In hand	.....	1,485.62	34,186.27
	.....	11,485.62	84,186.27
Outstanding liabilities at end of month	.....	1,175.00	2,883.26
Amount covered by existing contracts at end of month	.....	.....	26,187.93
	.....	1,175.00	28,571.19
Balance available at end of month	.....	10,310.62	55,615.08

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1900—Continued.

THIRD DISTRICT.

[Appropriations: Improving Mississippi River; improving harbor at Vicksburg, Miss.]

	Improving Mississippi River.				
	Surveys, gauges, and observations.	Lower Yazoo Levee district.	Upper Tensas Levee district.	Ashbrook Neck.	Lake Providence Reach.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	$72,929.32	$2,457,522.18	$3,656,562.34	$449,269.40	$3,548,180.14
Balance unexpended at end of last fiscal year	5,000.00	354,720.21	339,095.46	20,678.91	60,893.16
Amount appropriated or allotted since (net)				20,000.00	
	5,000.00	354,720.21	339,095.46	40,678.91	60,893.16
Amount expended from beginning of present fiscal year to end of previous month	3,064.97	335,312.77,	290,148.22	33,504.82	60,866.72
Amount expended during the month	12.00	1,858.65	12,357.82		5.22
	3,076.97	337,171.42	302,506.04	33,504.82	60,871.94
Balance unexpended at end of month	1,923.03	17,548.79	36,589.42	7,174.09	21.22
In Treasury United States	1,923.03	12,298.50	29,572.32		
In hand		5,250.29	7,017.10	7,174.09	21.22
	1,923.03	17,548.79	36,589.42	7,174.09	21.22
Outstanding liabilities at end of month		6,000.00	6,000.00		
Amount covered by existing contracts at end of month			4,000.00		
		6,000.00	10,000.00		
Balance available at end of month	1,923.03	11,548.79	26,589.42	7,174.09	21.22

	Improving Mississippi River.				
	Plant.	Greenville, Miss.	Delta Point, La.	Expended allotments.	Total.
Amount expended on previous projects					
Amount expended on present project to end of last fiscal year	$687,566.24	$800,212.43	$145,593.70	a $778,082.81	$12,595,918.56
Balance unexpended at end of last fiscal year	61,095.47	76,430.59	40,662.51		958,576.31
Amount appropriated or allotted since (net)					20,000.00
	61,095.47	76,430.59	40,662.51		978,576.31
Amount expended from beginning of present fiscal year to end of previous month	50,819.33	43,992.17	40,661.98		858,370.98
Amount expended during the month	7,599.76	3,681.26	.53		25,515.24
	58,419.09	47,673.43	40,662.51		883,886.22
Balance unexpended at end of month	2,676.38	28,757.16			94,690.09
In Treasury United States		25,000.00			66,870.82
In hand	2,676.38	3,757.16			27,819.27
	2,676.38	28,757.16			94,690.09
Outstanding liabilities at end of month	2,676.38				14,676.38
Amount covered by existing contracts at end of month					4,000.00
	2,676.38				18,676.38
Balance available at end of month		28,757.16			76,013.71

a Lake Bolivar front, $145,858.04; stone, $190,000; improving harbor at Vicksburg, Miss., $442,724.77.

Consolidated statement of condition of appropriations and allotments under Mississippi River Commission on June 30, 1900—Continued.

FOURTH DISTRICT.

[Appropriations: Improving Mississippi River; improving harbor at Natchez, Miss., and Vidalia, La.; improving harbor at New Orleans, La.; improving Atchafalaya and Red rivers, Louisiana.]

	Improving Mississippi River.			
	Surveys, gauges, and observations.	Lower Tensas Levee district.	Atchafalaya Levee district.	Lafourche Levee district.
Amount expended on previous projects..				
Amount expended on present project to end of last fiscal year	$80,137.14	$2,071,080.08	$1,195,072.94	$440,129.92
Balance unexpended at end of last fiscal year	5,000.00	277,018.91	175,086.72	88,354.00
Amount appropriated or allotted since (net)				
	5,000.00	277,018.91	175,086.72	88,354.00
Amount expended from beginning of present fiscal year to end of previous month	4,941.02	224,558.81	105,570.14	46,940.99
Amount expended during the month	58.98	10,458.44	4,202.59	3,845.77
	5,000.00	235,007.25	109,772.73	50,786.76
Balance unexpended at end of month		42,011.66	65,263.99	37,567.24
In Treasury United States		29,942.70	50,000.00	32,050.00
In hand		12,068.96	15,263.99	5,517.24
		42,011.66	65,263.99	37,567.24
Outstanding liabilities at end of month..		50.27	1,601.14	516.41
Amount covered by existing contracts at end of month		39,290.25	55,143.58	16,715.01
		39,340.52	56,744.72	17,231.42
Balance available at end of month		2,671.14	8,519.27	20,335.82

	Improving Mississippi River.				
	Barataria Levee district.	Pontchartrain Levee district.	Lake Borgne Levee district.	Bondurant.	Kempe Bend revetment.
Amount expended on previous projects..					
Amount expended on present project to end of last fiscal year	$262,947.83	$912,858.54	$285,167.79		
Balance unexpended at end of last fiscal year	57,785.04	159,975.94	45,527.34	$10,000.00	$180,000.00
Amount appropriated or allotted since (net)				10,000.00	
	57,785.04	159,975.94	45,527.34	20,000.00	180,000.00
Amount expended from beginning of present fiscal year to end of previous month	48,712.21	79,724.54	34,847.78		162,537.67
Amount expended during the month	449.07	13,498.43	507.20		245.80
	49,161.28	93,217.97	34,854.98		162,783.47
Balance unexpended at end of month	8,623.76	66,757.97	10,672.36	20,000.00	17,216.53
In Treasury United States		59,069.57		10,000.00	
In hand	8,623.76	7,688.40	10,672.36	10,000.00	17,216.58
	8,623.76	66,757.97	10,672.36	20,000.00	17,216.58
Outstanding liabilities at end of month..	1,138.47	971.49	289.84		71.40
Amount covered by existing contracts at end of month	5,014.43	51,841.12	7,900.54		5,975.00
	6,152.90	52,812.61	8,190.38		6,046.40
Balance available at end of month	2,470.86	13,945.36	2,481.96	20,000.00	11,170.13

Consolidated statement of condition of appropriations and allotments, under Mississippi River Commission on June 30, 1900—Continued.

FOURTH DISTRICT—Continued.

	Improving Mississippi River.				
	Plant.	Giles Bend.	Harbor at New Orleans, La.	Expended allotments.	Total.
Amount expended on previous projects..					
Amount expended on present project to end of last fiscal year	$29,887.27	$36,726.78		a$136,506.99	$5,400,465.23
Balance unexpended at end of last fiscal year	78,112.73	73,273.22	$18,750.00		1,168,833.90
Amount appropriated or allotted since (net)					10,000.00
	78,112.73	73,273.22	18,750.00		1,178,833.90
Amount expended from beginning of present fiscal year to end of previous month	47,251.30	73,273.22	488.23		828,340.91
Amount expended during the month	14,450.80		5,695.15		53,402.23
	61,702.10	73,273.22	6,183.38		881,743.14
Balance unexpended at end of month	16,410.63		12,566.62		297,090.76
In Treasury United States	1,000.00				182,062.27
In hand	15,410.63		12,566.62		115,028.49
	16,410.63		12,566.62		297,090.76
Outstanding liabilities at end of month..	6,541.07		133.04		11,313.18
Amount covered by existing contracts at end of month	9,869.56				191,749.49
	16,410.63		133.04		203,062.62
Balance available at end of month			12,433.58		94,028.14

	Improving harbor of Natchez and Vidalia, Miss. and La.	Improving harbor of New Orleans, La.	Improving Atchafalaya and Red rivers, Louisiana.	Grand total.
Amount expended on previous projects..				
Amount expended on present project to end of last fiscal year	$232,252.04	$862,874.23	$924,396.55	$7,419,968.05
Balance unexpended at end of last fiscal year	50,000.00	116,765.63	77,312.85	1,412,912.38
Amount appropriated or allotted since (net)				10,000.00
	50,000.00	116,765.63	77,312.85	1,422,912.38
Amount expended from beginning of present fiscal year to end of previous month	4,214.55	6,800.44	26,587.17	865,943.07
Amount expended during the month	1,366.12		1,837.69	56,606.04
	5,580.67	6,800.44	28,424.86	922,549.11
Balance unexpended at end of month	44,419.33	109,965.19	48,887.99	500,363.27
In Treasury United States	29,999.50	109,965.19	44,946.50	366,973.46
In hand	14,419.83		3,941.49	133,389.81
	44,419.33	109,965.19	48,887.99	500,363.27
Outstanding liabilities at end of month..	718.85		1,488.84	13,520.82
Amount covered by existing contracts at end of month				191,749.49
	718.85		1,488.84	205,270.31
Balance available at end of month	43,700.48	109,965.19	47,399.15	295,092.96

a Preservation of works, $134,000; dredges and dredging, $2,506.99.

Consolidated statement of all appropriations expended under the Mississippi River Commission to June 30, 1900.

Act of June 28, 1879 (organic)		$175,000.00
Act of June 16, 1880 (sundry civil)		150,000.00
Act of March 3, 1881 (river and harbor)		1,000,000.00
Act of March 3, 1881 (sundry civil)		150,000.00
Act of August 2, 1882 (river and harbor)		4,123,000.00
Act of August 7, 1882 (sundry civil)		150,000.00
Act of March 3, 1883 (sundry civil)		150,000.00
Act of January 19, 1884 (river and harbor)		1,000,000.00
Act of July 5, 1884 (river and harbor)		75,000.00
Act of July 5, 1884 (river and harbor), less $5,000 transferred to snag-boat service		2,065,000.00
Act of July 7, 1884 (sundry civil)		75,000.00
Act of August 5, 1886 (river and harbor), less $5,942.60 for expenses office Chief of Engineers		1,994,057.40
Act of August 5, 1886 (river and harbor), less $47.30 for expenses office Chief of Engineers		29,952.70
Act of August 11, 1888 (river and harbor), less $4,859 for expenses office Chief of Engineers		2,840,141.00
Act of August 11, 1888 (river and harbor)		75,000.00
Act of October 2, 1888 (sundry civil)		35,000.00
Act of October 19, 1888 (deficiency), less $4,214.39 reverted to the Treasury		20,785.61
Act of September 19, 1890 (river and harbor)		3,200,000.00
Act of September 30, 1890 (deficiency)		5,625.00
Act of March 3, 1891 (deficiency)		1,950.00
Act of March 3, 1891 (joint resolution)		1,000,000.00
Act of July 13, 1892 (river and harbor)		2,470,000.00
Act of July 28, 1892 (deficiency)		44.80
Act of March 3, 1893 (sundry civil)		2,665,000.00
Act of August 18, 1894 (river and harbor)		485,000.00
Act of August 18, 1894 (sundry civil)		2,665,000.00
Act of March 2, 1895 (sundry civil)		2,665,000.00
Act of June 3, 1896 (river and harbor)		909,000.00
Joint resolution approved March 31, 1897 (Public, No. 6)		250,000.00
Act of June 4, 1897 (sundry civil)		2,933,333.00
Act of July 19, 1897 (deficiency)		625,000.00
Act of July 1, 1898 (sundry civil)		1,983,333.00
Act of March 3, 1899 (sundry civil)		2,583,333.00
Act of March 3, 1899 (river and harbor)		185,000.00
Act of June 6, 1900 (sundry civil)		2,250,000.00
Total specific appropriations		40,984,555.51
Balances from former appropriations applied to works below Cairo under act of August 2, 1882, less $123.42 reverted to Treasury	$272,504.96	
Same for works above Cairo, under act of July 5, 1884	22,632.53	
Total balances		295,137.49
Amount received from Quartermaster's Department, U. S. Army, September 21, 1898, on account reimbursement for plant loaned during war of 1898 and lost at sea (taken up by Fourth District officer in January, 1899)		8,000.00
Total		41,287,693.00

Consolidated statement of all appropriations expended under the Mississippi River Commission to June 30, 1900—Continued.

EXPENDED.

Location and object.	To June 30, 1899.	During year ending June 30, 1900.	Total.
Mississippi River Commission	$547,094.80	$32,118.84	$579,213.14
Surveys, gauges, and observations	1,722,464.87	81,200.80	1,803,665.67
Levees	13,901,687.12	1,502,214.75	15,403,901.87
Revetment and contraction works, permanent channel improvements and protection	9,269,308.79	343,165.50	9,612,469.29
Dredges and dredging	1,572,670.40	455,879.23	2,028,549.63
Experimental dikes	*a* 9,145.43	44,693.39	53,838.82
Plant and miscellaneous	*b* 1,451,373.94	147,502.98	1,598,876.92
Improving harbors and tributaries	5,453,221.00	383,811.80	5,837,032.80
Works above Cairo	730,232.53	.....	730,232.53
Total expended	34,657,198.38	2,990,586.79	37,647,780.17
Balance unexpended June 30, 1900	.....	.....	1,349,423.83
Unallotted	.....	.....	2,290,489.00
Total appropriated, etc	.....	.....	41,287,693.00

a Formerly reported under plant and miscellaneous.
b Amount formerly reported reduced $9,145.43 now shown as an expenditure for experimental dikes.

LIST OF APPENDIXES ACCOMPANYING THE ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1900.

Appendix 1.

Paper by Maj. G. McC. Derby, Corps of Engineers, on changes in flood heights, Fourth district, Mississippi River.

Appendix 2.

Report of Capt. Mason M. Patrick, secretary of the Commission, on work done in the office of the Commission on surveys, gauges, and observations, dredges and dredging, and on experimental dikes (54 plates).
Money statement.
Abstract of proposals.
List of contracts in force.
Statement of charts issued and sold.
List of civilian engineers.
Approximate value of plant.
List of appendixes accompanying report of secretary.
List of plates accompanying report of secretary.

2 *A.*—Laws affecting the Mississippi River Commission July 1, 1899, to June 30, 1900.
2 *B.*—Specifications for the construction of self-propelling dredges *Kappa* and *Henry Flad.*
2 *C.*—Specifications for the construction of refrigerating plants for dredge *Iota* and large tenders.
2 *D.*—Report of Assistant Engineer A. T. Morrow on survey work and reconnaissance north of St. Paul, Minn., season of 1899.
2 *E.*—Report of Surveyor W. S. Williams on precise-level work of 1897–98 and 1900 below Fort Adams, Miss.
2 *F.*—Report of Assistant Engineer Kivas Tully on gauges, reduction of physical data, and office publications.
2 *G.*—Report of Assistant Engineer C. W. Sturtevant on dredging operations on the Mississippi River between Cairo, Ill., and Head of the Passes, Louisiana, and on care and repair of plant.
2 *H.*—Report of Assistant Engineer William Gerig on experimental dike work.

Appendix 3.

Report of Capt. E. Eveleth Winslow of operations in the First and Second districts (10 plates).
Report of Assistant Engineer Aug. J. Nolty on work done at Caruthersville and Plum Point Reach.
Report of Assistant Engineer W. M. Rees on work done at Hickman, New Madrid, Hopefield Bend, Memphis Harbor, and Helena.
Report of Assistant Engineer Charles Le Vasseur on dredging operations in Wolf River.
Report of Assistant Engineer Aug. J. Nolty on care and repair of plant.
Abstract of proposals.
List of civilian engineers.
Money statement.

Appendix 4.

Report of Capt. Charles L. Potter of operations in the Third district (7 plates).
Report of Assistant Engineer Arthur Hider on surveys, revetment work, stone, and the care and repair of plant.
Report of Assistant Engineer H. St. L. Coppée on levees in the Lower Yazoo Levee district.
Report of Assistant Engineer E. C. Tollinger on levees in the Upper Tensas Levee district.
Tables showing cost of work done by the United States on levees.
List of civilian engineers.
Abstract of proposals.
Money statement.

Appendix 5.

Report of Maj. Geo. McC. Derby of operations in the Fourth district (6 plates).
Money statement.
5 A.—Approximate value of plant.
5 B.—Commercial statistics.
5 C.—List of civilian engineers.
5 D.—Report of Assistant Engineer H. S. Douglas on work at Kempe Bend, Natchez and Vidalia harbors, and care and preservation of plant.
5 E.—Report of Assistant Engineer A. F. Wooley, jr., on work on Atchafalaya and Red rivers, Louisiana.
5 F.—Report of Assistant Engineer A. F. Wooley, jr., on concrete ballast.
5 G.—Abstract of proposals.
5 H.—List of contracts in force.

APPENDIX 1.

PAPER BY MAJ. G. McC. DERBY, CORPS OF ENGINEERS, ON CHANGES IN FLOOD HEIGHTS, FOURTH DISTRICT, MISSISSIPPI RIVER.

NEW ORLEANS, LA., *March 16, 1900.*

COLONEL: I have the honor to submit the following report on certain changes in flood heights in the Fourth district, which may have escaped the notice of the Commission and which may be found of interest.

In general it may be said that any study of the relations of gauge heights, while exceedingly interesting, is apt to be on the whole rather unsatisfactory. The number of variables in the problem is so very great that the mind is baffled in its efforts to keep track of them, and at the end remains unsatisfied as to the soundness of the conclusions reached. It fortunately so happens, however, that there is one long stretch of the Mississippi River where, through natural causes, many of the variables of this perplexing problem have been eliminated. This tempting field for investigation is, of course, the stretch of 200 miles lying between the mouth of Red River and New Orleans. At the next gauge below New Orleans the flood heights are so low and the mouth of the river is so near that the tides of the Gulf, small as they are, are sufficient to introduce perplexing complications, while above Red River outlets and tributaries combine with all the other uncertainties to make the problem as difficult

as it well can be. Between Red River and New Orleans there are practically no tributaries and but one small outlet. The length of the river is about constant. The levee system is less variable than elsewhere, and the effect of the tide at the Carrollton gauge is so slight that the height of the river may be assumed to be controlled entirely by the stream of water coming from above unaffected by variations of level having their origin below.

During the flood of 1897, which broke the high-water record at every gauge in the Fourth district, I was a good deal surprised and impressed by the fact that the first gauge to exceed its previous record was the lowest one, namely, the gauge at Fort Jackson. The next was the Carrollton gauge, and so on up the river to Red River Landing, where the gauge did not exceed its previous record until sixteen days after the Carrollton gauge had done so.

What was scarcely less surprising was the fact that when the Carrollton gauge reached its former maximum (17.45) the gauge at Red River Landing still lacked 1.6 feet of the height which in 1893 had produced that maximum.

Both of these remarkable facts point at first sight to the much-looked-for raising of the bed of the lower river with the consequent increase of flood height, which so many have claimed to be the ultimate effect of levee building.

Before attempting to seek the cause of these phenomena it will be well to ascertain first whether they represent merely curious anomalies peculiar to the flood of 1897 or whether they indicate any well-established tendency to a change in the regimen of the river.

To this end I submit Tables I, II, and III, premising that while the great excess in the low-water cross section of the lower river prevents the ratio between the gauge readings at Carrollton and Red River Landing from being constant for different stages of the river this cause does not operate to prevent the ratio from being constant when flood waves are compared, which all passed Red River Landing at substantially the same stage.

TABLE I.—*Flood waves which passed Red River Landing between 1872 and 1899 at an elevation of about 45.2.*

Year.	Red River Landing.	Carrollton.	Ratio.
1876	45.41	12.70	0.279
1883	45.2	15.4	.341
1884	45.95	13.8	.300
1890	45	16	.355
1891	45.5	16	.351
1898	44.3	15.8	.352

TABLE II.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 43.6.*

Year.	Red River Landing.	Carrollton.	Ratio.
1880	44.05	14.25	0.323
1887	43	14.5	.337
1898	44.3	15.8	.352
1899	43.3	16	.369

TABLE III.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 39.3.*

Year.	Red River Landing.	Carrollton.	Ratio.
1872	39.42	12.30	0.312
1873	39.02	12.93	.331
1885	39.35	12.65	.321
1898	39.2	13.2	.336
1894	39.5	13.4	.339
1898	39.6	13.8	.348

More evidence to the same effect could be adduced, but the above seems to be sufficient to establish clearly the proposition that the striking feature of the flood of 1897, under discussion, was not something abnormal, but that, on the contrary, such a change in the regimen of the river has actually taken place that we must now expect that any flood wave passing Red River Landing at a high stage will cause a flood wave at Carrollton a foot or more higher than a flood of the same height at Red River Landing would have caused fifteen or twenty years ago.

Now, if this is actually a fact it must be due to one or more of the three following causes:

1. A raising of the bed of the river below Carrollton, causing a decrease in the carrying capacity of that portion of the river.
2. The effect of crevasses and their closure.
3. An increase of the carrying capacity of the river between Carrollton and Red River Landing.

I will consider each of these possible causes in turn.

1. HAS THE BED OF THE RIVER RISEN?

If the apparent increase in the flood height at Carrollton is due to the filling up of the bed of the river below, it is manifest that such an effect would be proportionally more noticeable in the case of a low flood wave than it would be in great floods. I accordingly submit Tables IV, V, and VI, showing the gauge readings for many small flood waves which passed both gauges well within the banks of the river—a type of wave which usually receives but little attention, but which is in some respects more instructive than the greater waves.

TABLE IV.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 22.3.*

Year.	Red River Landing.	Carrollton.	Ratio.
1872	22.65	5	0.220
1875	22.2	4.4	.198
1875	21.8	5	.229
1879	22.85	6.7	.293
1881	22.35	5.6	.250
1885	21.85	5.25	.240
1888	22.25	4.88	.219
1889	22.4	6.58	.293
1894	22.4	4.1	.183

TABLE V.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 21.4.*

Year.	Red River Landing.	Carrollton.	Ratio.
1875	21.8	5	0.229
1876	20.9	5.10	.244
1885	20.9	5.7	.272
1886	21.85	5.25	.240
1887	20.9	5.85	.279
1899	21.2	4.6	.217

TABLE VI.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 19.3.*

Year.	Red River Landing.	Carrollton.	Ratio.
1873	19.4	3.78	0.194
1884	19.25	4.05	.210
1886	19.10	3.90	.204
1889	19.48	4.3	.221
1890	18.9	4.5	.238
1891	19.5	4.2	.215
1895	19.4	3.2	.165
1895	19.6	3.2	.163

An examination of these tables not only shows that the apparent increase of flood height at Carrollton is not more noticeable at low stages than at high ones, but it reveals, on the contrary, no trace whatever of any such apparent increase.

I conclude that whatever else the apparent increase of flood height at high stages may be due to, it is certainly not caused by a rise of the bed of the river below Carrollton.

2. THE EFFECT OF CREVASSES AND THEIR CLOSURE.

The extensive closing of crevasses below New Orleans or the prolongation of the levee line to some point nearer the mouth of the river might, by confining a larger volume of water to the river below Carrollton, cause, at least temporarily, a relative increase in the height of the Carrollton gauge.

In like manner the extensive closing of crevasses between Carrollton and Red River Landing might, by increasing the flow past Carrollton, cause an increase in the height of the gauge at that point.

But below New Orleans we have not closed, during the period under discussion, any crevasses which drew water from the river below a bank-full stage. If, then, I can show that the phenomena I am discussing obtain at and near a bank-full stage, it will be manifest that changes in the levee system below Carrollton can have had nothing to do with their causation.

To this end I invite attention to Tables VII, VIII, and IX, premising that a little over 8 feet on the Carrollton gauge represents the bank-full stage.

TABLE VII.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 31.2.*

Year.	Red River Landing.	Carrollton.	Ratio.
1877	31.4	8	0.255
1880	30.9	9.30	.301
1880	30.85	8.40	.272
1881	31.9	9.9	.310
1889	31.76	10.65	.335
1889	30.5	10.03	.328
1896	31.2	10.1	.323
1896	30.6	10.2	.333

TABLE VIII.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 30.4.*

Year.	Red River Landing.	Carrollton.	Ratio.
1880	30.9	9.30	0.301
1880	30.85	8.40	.272
1886	29.85	8.35	.279
1889	30.50	10.03	.328
1896	30.60	10.2	.333

TABLE IX.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 28.4.*

Year.	Red River Landing.	Carrollton.	Ratio.
1875	28.72	7	0.244
1892	28.4	8.7	.306
1894	28	8.5	.303

Above Carrollton the effect of crevasses is not quite so easily eliminated, because Bonnet Carré and Morganza crevasses were open for many years and drew their flow from quite a low level. But Bonnet Carré has been closed since 1883 and Morganza was closed in 1887, and since that date we have never had a crevasse below Red River with the gauge at Red River Landing reading less than 44.5.

If, then, it can be shown that the apparent increase in flood height at Carrollton has been progressive since 1887, and that such increase manifests itself in the case of flood waves which do not exceed 44.5 in height, we will have established the fact that crevasses are not the determining cause of the phenomena under discussion.

Tables X, XI, XII, and XIII show that such is precisely the case.

TABLE X.—*Flood waves which passed Red River Landing between 1887 and 1899 at about 43.6.*

Year.	Red River Landing.	Carrollton.	Ratio.
1887	43	14.5	0.337
1898	44.3	15.3	.352
1899	43.3	16	.369

TABLE XI.—*Flood waves which passed Red River Landing between 1887 and 1899 at about 33.4.*

Year.	Red River Landing.	Carrollton.	Ratio.
1889	33.6	10.95	0.325
1889	33.94	11.55	.340
1892	32.9	11.3	.343
1894	33.4	10.9	.326
1896	33.4	11.5	.344

TABLE XII.—*Flood waves which passed Red River Landing between 1887 and 1899 at about 39.4.*

Year.	Red River Landing.	Carrollton.	Ratio.
1893	39.2	13.2	0.336
1894	39.5	13.4	.339
1898	39.6	13.8	.348

TABLE XIII.—*Flood waves which passed Red River Landing between 1887 and 1899 at about 32.6.*

Year.	Red River Landing.	Carrollton.	Ratio.
1891	32.6	10.8	0.331
1892	32.9	11.3	.343
1899	32.4	11.2	.345

3. THE INCREASE IN THE CARRYING CAPACITY OF THE RIVER BETWEEN CARROLLTON AND RED RIVER LANDING.

If we are right in the conclusion that the apparent increase in the relative height of the Carrollton gauge is not due to the filling up of the bed of the river below, nor to the effects of crevasses above or below, there must have been an increase in the carrying capacity of the river above Carrollton, and Tables XIV and XV, with the others already given, show that this increase in carrying capacity must have taken place at such a height in the bed of the river as to manifest itself only at stages above 27 on the Red River Landing gauge.

TABLE XIV.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 27.*

Year.	Red River Landing.	Carrollton.	Ratio.
1873	27.9	8.10	.290
1878	27.1	7.65	.282
1880	26.99	7.63	.282
1881	27.2	8	.294
1884	28	8.5	.303
1885	26.9	7.7	.286
1886	26.7	7.6	.284
1887	27	7.6	.281

TABLE XV.—*Flood waves which passed Red River Landing between 1872 and 1899 at about 25.5.*

Year.	Red River Landing.	Carrollton.	Ratio.
1879	25.5	7	0.274
1883	25.92	7.50	.289
1888	25.56	7.20	.281
1890	25.1	6.8	.271
1892	25.1	6.4	.255
1892	25	5.8	.232
1893	25.2	6.4	.254
1893	24.9	6.2	.249
1897	24.8	6.6	.266
1898	25.2	6.6	.262

In the annual report of the Mississippi River Commission for 1899 the surveys made between Red River Landing and Donaldsonville are discussed, with results which are corroborative of the above discussion of the gauge readings, the conclusion having been reached that "the comparison of the results of all the surveys seems to show conclusively that there had been a general tendency to the permanent enlargement of the stream above the low-water line, and the capacity of the river to discharge its flood waters has been more than maintained."

The practical effect of this increase of the carrying capacity of the river between Carrollton and Red River Landing is to diminish the high-water slope, so that a flood wave producing a given height at the Carrollton gauge would pass Red River Landing to-day at a level several feet lower than would have been the case fifteen or twenty years ago. In other words, since the crevasses have been closed and the levee line maintained with few or no breaks there has been a notable decrease of flood height at Red River Landing, amounting apparently to 3 feet or more.

GEO. MCC. DERBY,
Major, Corps of Engineers, U. S. A.

Col. G. L. GILLESPIE,
Corps of Engineers,
President Mississippi River Commission,
Army Building, New York City.

APPENDIX 2.

REPORT OF CAPT. MASON M. PATRICK, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

MISSISSIPPI RIVER COMMISSION, OFFICE OF THE SECRETARY,
St. Louis, Mo., May 31, 1900.

COLONEL: I have the honor to submit the following annual report for the year ending May 31, 1900:

The work under the secretary of the Mississippi River Commission is carried on under allotments made by the Commission from appropriations for improving the Mississippi River between the Head of the Passes and the mouth of the Ohio River. These allotments are as follows:

(*1*) *Mississippi River Commission.*—Available for salaries, clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission.

(*2*) *Surveys, gauges, and observations.*—Available for the survey of the Mississippi River between the Head of the Passes and its head waters, for the establishment and maintenance of gauges, for special surveys and examinations, and for the collection and reduction of physical data pertaining to the Mississippi River.

(*3*) *Dredges and dredging.*—Available for the construction and operation of dredges and dredging plant for the Mississippi River from the Head of the Passes to the mouth of the Ohio River.

(*4*) *Experimental dikes.*—Available for the construction of experimental low-water dikes at localities below Cairo.

MISSISSIPPI RIVER COMMISSION.

The Mississippi River Commission held three sessions during the year, as follows:

Seventy-seventh session, June 16–19, 1899, at Army Building, New York City.

Seventy-eighth session, November 4–13, 1899, on board steamer *Mississippi*, St. Louis, Mo., to New Orleans, La.

Seventy-ninth session, March 14–20, 1900, on board steamer *Mississippi*, St. Louis, Mo., to New Orleans, La.

Plant and outfit.—The steamer *Mississippi* left St. Louis for the Government dry dock at Keokuk, Iowa, on June 1, 1899, where repairs were made to her hull and machinery. These repairs were completed, and toward the end of July she arrived at West Memphis, Ark., at fleet quarters. During August, September, and part of October she was in field service with the dredge fleet. Since then this steamer has carried the Commission on two inspection trips from St. Louis, Mo., to New Orleans, La., and the balance of the time has been laid up with the fleet at West Memphis, Ark.

SURVEYS, GAUGES, AND OBSERVATIONS.

Survey of the Mississippi River.—This survey, which is directed by the law creating the Mississippi River Commission to extend from the Head of the Passes to the head waters of the river, has been made with the view of obtaining accurate data for topographical and hydrographical maps which may be used in studying the physical characteristics of the river, and in planning improvements. The permanent survey marks are also intended to serve as a basis for future surveys, by which means changes in the bed and banks may be ascertained. The most approved methods have been used throughout in this work.

The field work consists principally of three parts, viz: Secondary triangulation, precise levels, and topography and hydrography. The instructions to field parties for this work will be found in Report of the Chief of Engineers for 1891, pages 3474–3485; the instructions for precise-level work, revised, will be found in the Report of the Chief of Engineers for 1899, pages 3469–3474.

A summary of the surveys of the river to 1896 will be found in the Report of the Chief of Engineers for that year, pages 3575–76.

The survey now covers the river from the Head of the Passes, 1,060 miles below, to Aitkin, Minn., 1,126 miles above Cairo, a total distance of 2,186 miles.

FIELD WORK DURING THE YEAR.

This work consisted of the topographical and hydrographical survey between St. Paul and Aitkin, Minn., a reconnaissance from Aitkin to the head waters at Lake Itasca, and rerunning the precise-level lines between Fort Adams, Miss., and Baton Rouge, La., on the lower river, and the side line from Carrollton, La., to Biloxi, Miss.

Topography and hydrography.—This work had been carried to the upper limits of St. Paul, Minn., where the field work had closed in the fall of 1897. During the season of 1898 the triangulation and precise levels had been extended northward to Aitken, Minn., a distance of about 200 miles. At the date of my last annual report a topographical survey party had just taken the field for the continuation of this work above St. Paul from the upper limit of the work of 1897. This party, in charge of Assistant Engineer A. T. Morrow, completed the survey of Minneapolis and to about 2 miles above the upper limits of the city about the middle of June. The hydrography was left to be done at the close of the season.

The party was then transferred to Aitkin, Minn., and worked downstream. At Aitkin a hydrographic party was also organized. The party numbered altogether about 45 men.

The season was not favorable for field work, as several considerable rises followed each other at short intervals down the river. Near Little Falls a log jam interrupted the work. With the exception of one or two short gaps left to be filled in the next season, the survey was completed to the upper limit of the work of 1897 by November 13, 1899, and the party was then disbanded.

The river between Aitkin and Minneapolis is radically different from that below St. Paul; the stream is narrow, with abrupt banks; the slope of the river averages about 2½ feet per mile. The bed is mainly gravel and bowlders, with some rock in situ at Little Falls, St. Cloud, and Minneapolis. Steamboating is impracticable at present, and the river is entirely monopolized by the logging interests.

The topographic work covered a strip on each side of the river about half a mile wide, and was extended to include towns, tributary streams, and other important topographical features. The work of the season covered about 190 miles of river in length and occupied about six months, during a portion of which time the conditions were unfavorable.

The following is the cost of the field work: Topography and hydrography, St. Paul, Minn., to Aitkin, Minn., May 6 to November 16, 1899, $20,632.75; per mile of river, $98.72. There were 266 square miles of topography and 21 square miles of hydrography. The cost of these items has not been separated. Adding the cost per mile of triangulation and precise levels done in 1898 ($86.92) to the above would make the total cost of all the field work over this stretch $185.64 per mile of river, this distance being taken as 209 miles.

Details of the season's work will be found in the report of Assistant Engineer A. T. Morrow, Appendix 2 D.

Discrepancies between ordinary and precise levels, river slopes, elevations of some prominent points, and descriptions and elevations of all the bench marks on this stretch of the river are given in Tables 1, 2, 3, and 4.

Descriptions of the triangulation stations and precise-level benches were published in Report of Chief of Engineers for 1899, pages 3385 to 3392 and 3408 to 3419. Descriptions of the precise-level benches and of any of the triangulation stations touched on by the ordinary levels are also given here in condensed form in Table No. 4, in order to make the present list complete.

Reconnaissance.—On account of the character of the country above Aitkin, Minn., it was decided not to carry the triangulation along the river above that point, but to substitute therefor tapeline measurements as a basis for the topographical work, and as a check on this work to carry the triangulation across country from Brainerd, Minn., to the head waters, thence down the river as far as practicable. A careful reconnaissance was made along the line and stations selected. An examination was also made of the river from Lake Itasca to Aitkin, Minn.

A party in charge of Assistant Engineer A. T. Morrow is now in the field carrying on the work laid out for this season.

Precise levels.—This work has been carried from the end of the jetties at South Pass to Aitkin, Minn., a distance of 2,269 miles; with side lines from the tide gauge at Biloxi, Miss., to New Orleans, La., a distance of 87 miles; from Savanna, Ill., to Chicago, Ill., 148 miles, and from Duluth, Minn., to St. Paul, Minn., 156 miles. About 110 miles of this between Cairo, Ill., and Helena, Ark., was done by the Engineer Department, U. S. A., before the creation of the Mississippi River Commission; the portion from Greenville, Miss., to Carrollton, La., a distance of 479 miles, was done by the United States Coast and Geodetic Survey from funds of the

Mississippi River Commission. The stretch from Baton Rouge to the end of the jetties was rerun in 1897–98 by the Commission; the stretch between Biloxi and New Orleans was rerun by the United States Coast and Geodetic Survey in 1886.

The releveling of the stretch on the main river from Fort Adams, Miss., to Baton Rouge, La., a distance of about 80 miles, and from New Orleans to Biloxi, a distance of 87 miles, has just been completed. This work was well done by a double precise-leveling party in charge of Mr. W. S. Williams, surveyor. On January 12, 1900, work was begun at Fort Adams, Miss., and closed at West Baton Rouge, La., on February 12. The party then proceeded to New Orleans and began work releveling the line from that point to Biloxi.

The line from New Orleans to Biloxi over the route of former leveling was completed about the end of March. The Biloxi tide gauge was connected with and a permanent monument was erected upon which to record the adopted value of mean Gulf level.

The results of this leveling between New Orleans and Biloxi are, at the terminal benches, about a mean between results of the former levelings in 1882 and 1886. The levels of 1886 made the New Orleans benches higher than those of 1882, as do also the present levels. The discrepancies are small and are probably entirely due to errors in leveling, rather than to any general change in the benches on this line. The results of the present releveling between Fort Adams, Miss., and Baton Rouge, La., make the Baton Rouge benches lower than do the levels of 1880. The releveling of 1897–98 from Baton Rouge to New Orleans and below make the New Orleans benches lower than do the levels of earlier years. From this it appears that the later levelings, starting with Fort Adams, diverge from the earlier levels down to New Orleans, where the discrepancy amounts to 220.2 millimeters; between that point and Biloxi this discrepancy is increased by 34.2 millimeters, making the total discrepancy between Fort Adams and Biloxi 254.4 millimeters. Only the reliable terminal benches have been considered in this comparison; the large and irregular discrepancies shown at many of the bench marks are no doubt due in some cases to disturbances of the benches themselves. Below New Orleans the earliest precise levels are those of 1893; the divergence found above New Orleans is also found below between the levels of 1893 and 1898, but the discrepancies are very irregular, due to the very unstable nature of the soil.

In view of the discrepancies found to exist between the earlier and later levels on the main river as far as the releveling has been carried, it seems unsafe to refer to the adopted mean Gulf level any bench marks except such as have been connected by this releveling, at least until the releveling is carried up the river to a point where the discrepancies practically disappear. The releveling now extends from Biloxi to New Orleans, up the river as far as Fort Adams, Miss., and down the river to the end of the jetties. The elevations of all precise-level bench marks on these lines have been referred to the adopted mean Gulf level, as was originally contemplated by the Commission, and will be found in Tables Nos. 7, 8, 9, and 10. It is the intention to refer all bench marks of the survey to this datum so soon as they have been reliably connected therewith.

Details of this season's work will be found in the report of Mr. W. S. Williams, Appendix 2 E.

Subsidence of the delta.—This question has been discussed at some length in former reports of the Commission. See Reports of the Chief of Engineers for 1894 and 1896, pages 2794 and 3478, respectively. Subsequent investigations have furnished additional data, and it is believed that now sufficient information has been collected to show conclusively that the lower delta of the Mississippi River is subsiding. The amount of this subsidence from 1892 to 1896 is approximately determined by a comparison between the Port Eads and Biloxi tide gauges; between 1895 and 1900 it is quite accurately shown by a similar comparison of the East Bay gauge with the Biloxi gauge. Plate 10, Report of the Chief of Engineers for 1899, page 3502, shows that the Port Eads gauge is materially affected by the river stages, while the East Bay gauge is but slightly affected by the river, and only at very high stages; hence the latter gauge gives more accurately the true Gulf level at the delta, and the comparison of this gauge with the Biloxi gauge is entitled to more weight. The East Bay gauge was established in 1895, the Port Eads gauge in 1876. Prior to 1895 the Port Eads records are the only ones available for comparison with Biloxi; the resulting differences must be regarded as but approximately representing the subsidence of the delta.

The level connections between the gauges and their local bench marks show no appreciable change in their relations. The changes in the relations between the Biloxi gauge and the gauges near the mouth of the river must therefore be attributed to a raising of the strata at Biloxi or a lowering of the strata of the delta, or to both. The recent leveling between Biloxi and New Orleans shows conclusively that no

such raising has taken place at Biloxi; the conclusion that the delta has subsided seems, therefore, inevitable. By comparison between Biloxi and Port Eads from 1882 (the earliest Biloxi record) to 1896, the subsidence amounts to 0.696 foot; from 1896 to 1899 by the same gauges it amounts to 0.31 foot; a total for the period from 1882 to 1899 of 1.006 feet, or an average rate of 0.056 foot per year. By comparison between the Biloxi and East Bay gauges, 1896 to 1899, the subsidence is 0.316 foot, or an average annual rate of 0.079 foot. The subsidence from year to year between these dates is not uniform, and therefore can not properly be used in deducing a rate prior to 1896.

The subject is one of great interest, and it is recommended that the observations be continued. For further details and for the tables showing the yearly comparisons attention is invited to the report of Assistant Engineer Kivas Tully, Appendix 2 F.

Scour and fill survey.—A party in charge of Mr. Charles H. Miller, surveyor, was organized in August, 1899, for this work. The object of the survey is to ascertain by means of careful soundings on fixed ranges the nature and extent of changes occurring in a given portion of the river during varying stages of water. New Madrid bend was the selected locality, and a preliminary survey was made by means of triangulation and stadia early in September, 1899. Thirty-one cross sections or ranges were located, covering about 5½ miles of river. The bars above water were profiled by level lines in prolongation of the river cross sections or ranges. Level lines connected by river crossings were run over the reach along each bank and the levels connected with permanent bench marks of the general survey.

A complete set of soundings has been taken over the reach about once each week. These soundings have been taken with great care with pole or lead line and located from shore with a transit. The soundings have been platted in the field and the plats forwarded to the St. Louis office, where they are being checked and the areas measured. From the areas will be derived the mean datum depths and scour and fill of the river bed. The field and office work are in progress; it is not expected that the complete results will be available for insertion in this report. A map of the reach showing the location of the ranges and gauges, and platted cross sections on the ranges, will be found on Plate 1.

Gauges.—The permanent river gauges of the Mississippi River Commission have been maintained during the year; these comprise 14 on the main river, 1 on the St. Francis, 1 on the White, and 1 at Barbre Landing at the head of the Atchafalaya River. Beside these, the self-registering tide gauge at Biloxi, Miss., has been maintained.

All the Commission gauges on the main river and the one at Barbre Landing have been inspected during the year. The inspection was made during October and November, at about the lowest stage of the season, and furnished an unusually good determination of extreme low-water readings. The errors found in the gauges were generally small, less than two-tenths foot, except at Bayou Sara and at Barbre Landing, where the low-water sections were found to be 2.2 and 2.36 feet too low, respectively.

The highest and lowest gauge readings for 1899, together with extreme readings previously recorded and distances and elevations of gauges, are given in Table No. 15. A hydrograph of the main river is given on Plate 3. A comprehensive hydrograph of the Mississippi River and its principal tributaries, 1871 to 1899, is given in Plate 4.

In addition to the permanent gauges, high-water gauges at intervals of about 5 miles from Cairo to Fort Jackson have been maintained. These were inspected and repaired and arrangements made with local observers to report the readings in case of high water during the present season. The automatic tide gauge at Biloxi, Miss., was inspected and connected with by the precise level party about the end of March, 1900. The tide rolls of this gauge have been reduced, and the mean reading for 1899 deduced therefrom corrected for a slight change found in the staff gauge, the corrected value being 6.072. The adopted value for mean Gulf level is 6.083 feet. The adopted value would not be appreciably changed by combining 1899 therewith.

Low-water slope.—The water surface elevations at or near the sites of all the high-water gauges have been determined during the lowest stages of the river in October and November by the gauge inspection party. The continuously low stage of the river was extremely favorable for the work, and very satisfactory results were obtained between Cairo and mouth of Red River. Below that point the tidal effect is so marked at low stages of the river that slope observations can have but little value. The results of this work are given in Table No. 16, and a profile is shown on Plate 2.

Discharge observations.—The low-water discharge in the Mississippi River was measured by the scour and fill survey party six times during October and December, 1899. These were the only discharge observations made during the past year. The results

of the final reduction of these discharge measurements will be found in Table No. 18. The results of simultaneous readings of different current meters are given in the same table. The location and cross section of the discharge range are shown on Plate 1.

A plat has been prepared showing all measured discharges of the Mississippi River below Cairo which exceeded 1,000,000 cubic feet per second, together with the gauge and mean velocity curves (see Plate 5). These comprise measurements of sixteen floods, from 1851 to the latest observations—those of 1898. These discharge data have been collected from the various official reports, covering a long period of time, and it is believed that their graphical representation on one plate will greatly facilitate their study. All the gauge readings being referred to the present gauge at each station brings out very clearly the variation of river discharge for a given gauge reading.

For further details attention is invited to report of Assistant Engineer Kivas Tully, Appendix 2 F.

Plant and outfit.—This now consists, with the exception of some skiffs and small boats, of the steamers *Patrol* and *Search*. The *Patrol*, which was laid up at West Memphis at the date of my last annual report, had some minor repairs made, and on July 9 was assigned to bar surveys in connection with dredging operations. She remained in this service until the end of September. About October 1 this boat took out the gauge inspection party from Cairo to Fort Jackson, returning to Memphis about the end of December. The inspection party was then transferred to the steamer *Search* and the *Patrol* was assigned to the precise level party. After the completion of the line from Fort Adams to Baton Rouge, the precise level party was taken to New Orleans, and the *Patrol* returned to West Memphis, where she was laid up on March 9, 1900.

The steamer *Search* at the date of my last annual report had been hauled out on the bank at West Memphis and repairs to her hull were in progress. New stern posts, transoms, fantail guards, cylinder timbers, and some hull timbers were put in. She was relaunched on July 22. Some repairs were made to her wheel and her machinery was reassembled. Early in August the boat was put in commission as inspection boat in connection with dredging operations, and remained in this service until the end of December, when she was assigned to take the place of the *Patrol* with the gauge inspection party from Memphis to Cairo. Early in January, 1900, she was laid up with the fleet at West Memphis, and has since had some repairs made and been repainted.

Published maps.—Maps have been prepared and published by the Commission to date as follows:

A map of the lower alluvial valley from vicinity of Cairo to the Gulf of Mexico, in eight sheets, scale 1 inch to 5 miles, was published in 1887. A new edition of this map, with changes and additional data, was published in 1899.

A map of the valley of the Mississippi River from Cairo, Ill., to St. Paul, Minn., in four sheets, scale 1 inch to 5 miles, was prepared and the last two sheets published in 1899.

A district map of the Mississippi River from Cairo to the Gulf, showing limits of improvement districts, levee districts, etc., in one sheet, scale 1 inch to 5 miles, was published in 1897.

Detail charts of the river, scale 1 : 20,000, showing the topography and hydrography from the Head of the Passes to near La Crosse, Wis., a distance of 1,763 miles, have been printed and issued in 155 sheets; ten of these sheets were printed during the year; six more sheets are now in the hands of the printer. This series will be published to Minneapolis, Minn., on this scale, and from thence to Lake Itasca on a scale of 1 to 10,000.

Maps on a scale of 1 inch to 1 mile, from the Gulf of Mexico to above Lansing, Iowa, a distance of about 1,780 miles, have been printed and issued in 60 sheets; four of these sheets have been printed during the past year; two more sheets are now in the hands of the printer. The first edition of some of the sheets of these inch-to-mile maps below Cairo has been exhausted. Preparations are being made to reprint these sheets, adding thereto data derived from the most recent surveys.

Reduction of field notes.—The reduction and platting of the field notes of the topographical and hydrographical survey from St. Paul, Minn., to Aitkin, Minn., have been carried on in the office by members of the survey party since the close of the field season last November. All the computations and about one-half the platting have been completed. Descriptions of bench marks and other tables of data relating to this stretch of the river have also been prepared. The final computations of precise levels recently run between Fort Adams and Baton Rouge, and New Orleans and Biloxi, have been made and the results tabulated.

Mapping and drawing.—Detail charts 170 to 179, covering the upper river from

below Brownsville, Minn., to Wabasha, Minn., a distance of about 95 miles, have been completed. Charts 180 to 188, of the same series, are partly drawn.

Inch-to-mile maps 127 to 130, covering the river above Cairo from near Glen Haven, Wis., to above Trempealeau, Wis., a distance of about 78 miles, have been completed.

Inch-to-mile maps 12 to 25 below Cairo are being prepared for republication, the first edition of these sheets having been exhausted.

DREDGES AND DREDGING.

Project.—On the 20th of June, 1896, the Mississippi River Commission adopted a project for obtaining and maintaining, by means of dredges, a channel in the Mississippi River below Cairo, with a width of 250 feet and a depth of at least 9 feet throughout the year, except when the river is closed by ice. This project provided for the construction and operation of seven hydraulic dredges by the 30th of June, 1900, and for the provisional construction of two others, if found necessary.

The building of this plant has formed a very important part of the work of this office, and has involved the preparation of plans and specifications for the dredges themselves, and for the necessary large and small tenders, pile sinkers, and other plant. Since the beginning of the construction of this dredging plant many changes have taken place in the method pursued to procure the most efficient and best-designed dredges.

The first dredge was built after plans prepared by the dredging committee, and was in the nature of an experiment. While many changes in this boat were afterwards found necessary, it yet demonstrated beyond a doubt the efficiency of such hydraulic dredges for the purpose for which it was designed.

The next step was to define, in general terms, the conditions which the dredges must fulfill, leaving to the builders the details of the design. Following this course, three dredges were built. Experience was constantly being gained, until a point was reached where it was possible to outline, with greater accuracy, nearly all the details of construction. Under such specifications, two more dredges were built. Under still more rigidly drawn specifications another, the seventh, a self-propelling dredge, was placed under contract in 1898. This dredge is now about completed, and will probably be delivered at an early date. The eighth and ninth dredges, also to be self-propelling, are now being built.

CONSTRUCTION, ALTERATION, AND REPAIRS TO PLANT.

Dredge Alpha.—This dredge was not put in commission during the year, but remained in service as a quarter boat and machine shop. It was intended to haul out the *Alpha* to have the hull calked and otherwise repaired, but this work has been postponed until after further consideration of the future disposition or alteration of the boat, which at present is not an economical machine for use on the Mississippi River, owing to the narrow cut it can make and to the shallow depth at which it can work.

Dredge Beta.—At the date of my last annual report this dredge was at West Memphis; the alterations to provide cabin accommodation for the crew and to decrease the draft of the boat had just been finished. In June, 1899, the outfit was placed on board, and in July the dredge was tested under field conditions near the head of Presidents Island. The efficiency of the dredge has been greatly increased by the alterations. The draft, when fully equipped and under working conditions, with water in the boilers, is now about 52 inches. Early in August, shortly after being placed in commission, one of the piston rods on the starboard engine became heated. The rod and glands were so badly scratched that it was necessary to have the rod turned off and the glands rebushed. Owing to the great size of the dredge and to the strain on the cables when working in a strong current, the main gear wheels of the winding engines proved to be too weak. Many of the teeth were broken. Temporary repairs were made while in the field.

After the season's work was finished all the machinery was thoroughly overhauled. It was found that the pump casings had worn considerably and in an irregular manner. These casings were bored out and new plates fitting the casing closely will be placed upon the runner blades. It is the expectation that the pumps will stand another season's wear in their present condition, but after next season it will probably be necessary to line the pump casings. New and stronger main gear wheels have been provided for the hauling engines. The *Beta's* pontons, as originally built, did not furnish sufficient flotation to support the pipe line when the latter was filled full of sand; when in such a condition pipes and pontons would sink and turn over. Such an accident happened once during the dredging season, and once again was narrowly averted. Steps have been taken to provide additional flotation for the pontons and after the work is completed no such trouble can again occur.

The *Beta* is deficient in boiler power. To run both pumps and the rest of the machinery it is necessary to force the boilers far beyond their rated capacity. Although the best grade of coal is used, there is great difficulty in firing. The stokehole is exceedingly uncomfortable, and the firemen can endure the work for but a short time. During the exceedingly hot weather it was found impossible to supply sufficient steam to run more than one pump. New grates which are more easily cleaned are being provided for one-half the boilers, and if found advantageous the other boilers will probably be equipped with the same device. Steps have also been taken to better ventilate the stokeholes.

Dredge Gamma.—Shortly after being placed in commission, while at work at Fleeces Crossing, it was found that the valve and valve seat of the high-pressure cylinder were rapidly wearing. This wear continued at such a rate that it was necessary to lay up the dredge, have the valve seat planed off and procure a new valve. This excessive wear is probably attributable to the dryness of the steam and to improper lubrication. After the new valve was put in place the dredge worked throughout the season, but when laid up in winter quarters it was found that considerable wear had taken place at the same point. The cylinder was taken to the shop, the valve seat again planed off, and a false seat made of bronze plate about nine-sixteenths of an inch in thickness, held by studs, was put in place. The cast-iron liners placed in the pump before the beginning of the last season's work answered their purpose well, but wore away considerably. New liners made from the same patterns were obtained and put in place. The pontons of this dredge are not sufficiently large to support the pipes when filled full of sand. Small cylindrical pontons which will provide the necessary flotation have been ordered and will be put in place.

Dredge Delta.—The new chains for operating the cutters on this dredge were not delivered in time, and the boat was put in commission with the old worn chains. These old chains gave a great deal of trouble and caused many delays. After the new chains were received and put in place no further delays of this nature were experienced. Most of the delays caused by the cutters had been due to sunken logs jamming between the cutter blades. To obviate this, circular steel plates were put alongside each of the cutters. This device worked in a very satisfactory manner. After the close of the dredging season the machinery of the dredge was all overhauled. The piston rod of the low-pressure cylinder had given considerable trouble in the past and had undoubtedly been of too weak a design. It was determined to slightly increase the size of the piston rod. While boring out the eye of the piston to fit the new rod a large blowhole was found, which would so weaken this part of the piston head that it was necessary to order a new piston head from the builders of the engine. Considerable wear had taken place on the lining plates of the pump casing. The old plates on the after side of the casing were removed and new ones will be fitted in their places.

Dredges Epsilon and Zeta.—The work of putting the cast-iron liners in the pumps was completed, and during the low-water season nothing but minor repairs were made to these dredges. After being laid up in winter quarters all the machinery was thoroughly overhauled. The pump casing liners had worn as had been expected, and new liners were procured and put in place. It was also found that the pump runners had worn to such an extent that they could no longer render efficient service. New runners have been cast and are now being put in place.

On all the dredges the hulls have been thoroughly cleaned and oiled; the boilers have been tested and repaired where necessary.

Dredge Iota.—This dredge was built under contract with the Springfield Boiler and Manufacturing Company. The contract required the boat to be delivered by the 26th of August, 1899, but owing to many delays the builders were unable to deliver the boat in time for work during the low-water season. The time for delivery has been extended to the 1st of July, 1900. The boat is nearly completed and will probably be delivered for test at an early date.

Dredges Kappa and Henry Flad.—At the date of my last annual report, proposals for building these dredges had been opened and the bid of the Bucyrus Company, of South Milwaukee, Wis., had been recommended for acceptance. This recommendation was approved and a contract was entered into with the said company for the construction of these dredges. Although the contract requires the dredges to be finished and delivered by the 1st of July, 1900, no great progress has yet been made upon these boats. The contractors claim to have done all in their power, but that they have been hampered by their inability to obtain the necessary material. Part of the machinery has been finished. The hulls are being built at Grafton, Ill.; the pumps and machinery at South Milwaukee. Neither of the boats has yet been launched, and it is now evident that they can not be completed by the date set in the contract for their delivery.

Large tenders.—The five large steam tenders, named *Sachem*, *Choctaw*, *Nokomis*, *Wynoka*, and *Leota*, were completed by the contractors, the Iowa Iron Works, Limited. The first two boats were put in commission in October and reported for duty in the field on the 12th of that month. Two more reached winter quarters at West Memphis on the 4th of December, and the fifth boat reached the same point on the 20th of December, 1899. Each of the five boats received its equipment at St. Louis. The boats were well built, and, although no exhaustive tests have been made of them, they have had sufficient trials to demonstrate that they are thoroughly capable of handling the dredges; that they are well-designed and efficient tenders. These boats handle easily and have ample power.

Small tenders.—The four small tenders, *Vulcan*, *Mercury*, *Venus*, and *Mars*, rendered efficient service during the year, transporting survey parties from point to point and in making surveys of the different stretches of the river. They are very economical and prove to be especially well suited for such work. No repairs of consequence were necessary during the working season. While in winter quarters, it was discovered that the shaft of the *Vulcan* was cracked, and it was necessary to obtain for this boat a new shaft, which has been put in place. It was also found more convenient to slightly alter the *Mars* by turning the boiler around, and it is proposed to make the same change on the *Mercury* and *Venus*.

Steamer Minnetonka.—Some minor repairs have been made to the starboard guard, and the wheel has been rebuilt.

Steamer Vidalia.—This boat, having been worn out in the service, was inspected, condemned, and sold on the 15th of June, 1899.

DREDGING OPERATIONS ON THE LOWER MISSISSIPPI RIVER BETWEEN CAIRO, ILL., AND THE HEAD OF THE PASSES, LOUISIANA.

These operations include the care and repair of plant, testing of dredges, and operation of the plant during the low-water season.

A statement of the general principles which have governed the conduct of the dredging operations will be found in the Report of the Chief of Engineers for 1898, pages 3166–3169.

No fixed rules can be laid down for the locations of the channels to be dredged. Each case as it arises must be studied with care, and the dredges placed after a thorough examination of the locality and all existing conditions. To successfully solve these problems and to properly locate the channels to be dredged, in my opinion, it is essential that detailed surveys of the various localities should be made from time to time. It is not always sufficient to know the condition of affairs at the time when the dredging is to be done. It is frequently an advantage to have some knowledge of the prior conditions, of what changes have already taken place, and of what the river is trying to do for itself. The plan pursued during the last dredging season was to make rapid surveys of the different points where it was expected that dredging would be needed, some little time before the river fell to a stage where dredging would be required. Surveys were again made just before putting the dredges to work. Studies of the results of the surveys, together with personal observation of the localities in question, enabled a decision to be reached as to the best place to attempt to cut across the bars. It may be said that during the low-water season of 1899 there was practically but one place where the channel first located had to be abandoned and another selection made. Reference will be made to this later in my report, where it will be seen that the first selection was somewhat of an experiment, which offered, it was believed, a fair chance of success; but conditions so changed later that it became necessary to abandon the first locality and open another channel a short distance away from that first selected.

In addition to the surveys, efforts were also made to plainly mark the dredged channels by means of keg buoys. These buoys were moved from time to time as the channel shifted. It is believed that they will prove valuable aids to navigation as soon as the pilots learn that they can rely upon the buoys being correctly placed. Frequent reports were made to the pilots' associations; and by permission of the officer in charge of the local light-house district, the positions of the lights were occasionally changed to agree with the new channels which developed or were made by the dredging. Every effort was made to give full information to steamboatmen and to make the dredging operations of as much value as possible. The work of each dredge is given in detail below.

Dredge Beta.—As this dredge can excavate to a greater depth (20 feet) than any of the other dredges, it was placed in commission and put to work while there was still considerable depth in the channels. The boat first worked at Fleeces Crossing (243), where dredging was commenced on the 2d of August, 1899. The boat was next moved to Presidents Island and commenced dredging at that locality on the 28th of

August. The necessary dredging here was finished on the 3d of September and the boat was sent to Cherokee Crossing (90), where dredging was begun on the 9th of September. On the 12th of October the dredge was moved to Point Pleasant (79) and began work. On the 10th of November the boat left Point Pleasant for winter quarters and arrived at the fleet at West Memphis on the 13th of November, 1899.

Dredge Gamma.—This dredge was placed in commission on 12th of August and was sent to Fleeces Crossing (243) to assist the *Beta*. Dredging commenced on the same day. Owing to the wearing of the valve and valve seat on the high-pressure cylinder, it was necessary to temporarily lay up the dredge until the repairs could be completed. The dredge was idle between August 26 and September 7; on the last named date it returned to Fleeces Crossing and resumed dredging. After completing the work at this point, the *Gamma* was moved to Cypress Bend (426), where the somewhat narrow and crooked channel was widened and straightened. Dredging was commenced at this locality on October 29 and continued until November 4. On the 7th of November the *Gamma* started upstream, and on November 9 commenced dredging at Beiths Crossing (366). This work was finished on November 16; the *Gamma* reached winter quarters on November 20, 1899. By direction of the Secretary of War, this dredge was temporarily transferred to the engineer officer in charge of the improvement of Vicksburg Harbor, and left the fleet for Vicksburg on March 28, 1900, towed by the steamer *Choctaw*. The dredge left Vicksburg on May 11, 1900, arriving at the dredge fleet on May 21, 1900.

Dredge Delta.—This dredge was placed in commission on the 9th of August and towed to Island No. 34 (179), where work was begun on the 11th of August and continued at intervals until the 13th of September. The next day the dredge started for Graves Bayou (250), where it seemed that work would be needed. The river, however, without assistance formed a new channel at this point, and no dredging was necessary. A shoal had formed a short distance above where the *Delta* had worked at Island No. 34, and the dredge was therefore returned to this locality, where dredging was resumed on October 22 and finished on October 25. The *Delta* was retained in this vicinity, but did no further work, and on the 17th of November was laid up in winter quarters.

Dredge Epsilon.—This dredge was placed in commission on the 15th of August and left winter quarters for Miss Hickmans Crossing (131), reaching that point on the 19th of August; dredging was begun on the 21st of August and completed on the 1st of September. The *Epsilon* was moved to Cherokee Crossing (90) and commenced dredging on the 5th of September. Work was continued with little interruption until the 22d of September, when it was temporarily suspended. Dredging was resumed on the 28th of September and continued until the 6th of October. On the 4th of November the dredge was again put to work to remove a lump which had formed at the lower end of the channel. This work was finished on the 6th of November. On the 11th of November the *Epsilon* was moved to Point Pleasant (79); work was begun the same day and continued without serious delay until the 17th of November. As no further work seemed necessary, the dredge left Point Pleasant on the 26th of November and arrived at winter quarters on the 28th.

Dredge Zeta.—This dredge was put in commission on the 26th of August, 1899, and on that day started for Luxora (163), where dredging was begun on the 27th of August and continued without serious delay until the 12th of September. Work was resumed on the 22d of September and continued at intervals until the 3d of October. On the 10th of October the dredge was moved to Osceola Bar (164). After two days' dredging the necessary work here was finished and the *Zeta* returned to Luxora, where a lump had formed near the central portion of the dredged channel. Work was resumed at this locality on the 13th of October and continued for four days. On the 24th of October the dredge was moved to Fletchers Landing, at the lower end of Gold Dust Crossing (158). On the 2d of November the work at this locality was finished. On the 4th of November the dredge again resumed work at Luxora, removing a lump which had formed in the channel. This work continued until the 8th of November. The dredge was retained in this vicinity to await developments, but no further work was found necessary, and on the 26th of November the *Zeta* departed for winter quarters, arriving at West Memphis the next day.

A summary of the dredging operations and distribution of time and of expenditures will be found in Tables Nos. 20 and 21.

DISCUSSION OF RESULTS.

The low-water season of 1899 was especially favorable for dredging operations. As will be seen by an inspection of the hydrograph on Plate 3, the river for a comparatively long period was stationary or falling. Under such conditions channels once made do not, as a general rule, fill up, and are easily maintained. During the last

low-water season the river reached a comparatively low stage. Some of the lowest gauge readings during the year were as follows:

	Date.	Reading.
		Feet.
Cairo	Oct. 16, 1899	2.98
Fulton	Oct. 30, 1899	2.63
Memphis	Oct. 31–Nov. 1, 1899	0.54

The river remained below 5 feet at Cairo for forty-three days, from September 30 to November 11, inclusive. The bars where work was done were carefully surveyed before, during, and after dredging. The results are shown on Plates 6 to 50, where depths greater than 9 feet are indicated by parallel ruling.

Vicinity of Point Pleasant (81–83).—This locality was about the most difficult of any on the river below Cairo. During the early part of the low-water season navigation was not seriously hindered, but toward the latter part of the season boats experienced a great deal of trouble at the lower Point Pleasant Crossing. The conditions from time to time are shown on Plates 6–10. Dredging at this point was postponed as long as possible in order that a fair test might be made of the efficacy of the dikes which were here being put in position. When it was found that the dikes had failed to secure a navigable channel, the dredges were put to work. The dredge cuts were located with a view of assisting the dikes and giving speedy relief; these cuts were not located as would probably have been the case had the matter not been complicated by the presence of the dikes. The channel opened was crooked, narrow, and hard to run.

Cherokee Crossing (90).—Plate 11 shows the conditions before dredging. This is a broad, flat, crossing, with no well-defined low-water channel. The location of the dredged cut is shown on Plates 12–16. The work was very satisfactory. Occasionally large lumps formed in the dredged channel which had to be removed, but after the channel was once opened there was never less than 9 feet of water on this crossing. Plate 16 shows an excellent channel thirty-nine days after dredging.

Miss Hickmans Crossing (131).—See plates 17–21. Plate 17 is from the preliminary survey and shows the conditions that then existed. Plate 18 shows the location of the channel which was afterwards dredged, and the remaining plates show the results of the dredging. At no time during the year was there less than 9 feet over this crossing. The dredged channel widened and deepened, and no trouble was here experienced by passing boats.

Gold Dust Crossing (158).—Plate 22 shows where the small amount of dredging found necessary was done at this locality. The results were very satisfactory.

Luxora Crossing (162).—Plates 23 and 24 show the conditions before any dredging was done. The problem of properly locating the dredge cut at this point was a rather complicated one. A bold reef running out from Elmot Bar stretched diagonally across the river, with a deep pool on either side. The earlier surveys show a narrow connection between the pools just below the Luxora warehouse. It became a question whether to cut across the reef at some point above the Elmot warehouse (Plate 24), or to attempt to open the channel close along the right-hand shore in front of Spann's warehouse and Luxora warehouse. As the best steamboat landing was near the Luxora warehouse, this last-named locality was finally selected; it was thought that if the channel along this shore could be maintained, it would be of great advantage to all local steamers. The channel was successfully opened and maintained, although occasional dredging was necessary from time to time. After the dredging was done, at no time was there less than 9 feet in this channel. It is probable that an equally good or better channel could have been opened and maintained with less work at some other point across the bar, but for the reasons given above, the final selection of the locality where work was done is believed to have been the best that could have been made under the circumstances. Plates 25–27 show this locality at various times during and after dredging.

Vicinity of Osceola Landing (164).—After passing Luxora the river divided, part of the water going down along the face of Osceola Bar, while another channel crossed over to Island No. 30. After a study of the existing conditions it was decided to improve the first-named channel. The locality where dredging was done and the results obtained are shown on Plates 28–31.

Island No. 34 (179).—At this locality there were really three distinct channels—one passing between the bar and the island, one along the face of the bar, and the third down close to the left-hand shore. This last-named channel was narrow, crooked,

and much obstructed by logs and snags. The channel between the bar and island had shoaled in previous years, and there was every indication that the same state of affairs would exist during this season. It was therefore determined to improve the middle channel, and the cut was located near the same place where dredging had been done the year before. The material encountered was heavy gravel, lignite, and blue clay. Once opened, the channel was easily maintained, although a lump which had to be removed formed near the upper end of the cut first dredged. The work done and its location are shown on Plates 32–36.

Presidents Island (*233*).—Plate 37 shows this locality some little time before the dredging. Conditions had changed but slightly when work became necessary. Here was a very distinct case of overlapping pools, and the problem was to determine where best to open a channel across the intervening bar. The location finally selected is shown on Plate 38, and on Plates 39–42 are shown the results obtained. At no time was there less than 9 feet over this crossing.

Fleeces Crossing (*245*).—This was the first locality where shoal water developed during the season, and was the first point at which dredging was done. Plate 43 is from a survey made in the latter part of July, at which time the pilots reported but 10 feet over this crossing. The river was falling slowly and was still about 10 feet above mean low water. It was seen that there would be considerable time before a very low stage would be reached. It was determined, however, to put the dredge *Beta* to work at once, and the cut to be dredged was located after considerable study. As shown on plate 43, at this time there were really two channels in existence; one turned sharply across the river between the two sand bars; the other, straighter, though much longer and not quite so deep, followed down about the middle of the river. It was thought well to attempt to keep open this longer and straighter channel with the hope that once the water was flowing freely through it it would be maintained, and that the other channel would ultimately be closed. The location of the dredged cut is shown on plates 44, 45, and 46. The channel was opened and for a time maintained. The current passing through it was quite swift; but the sand, which was fine, was easily moved and the channel became quite crooked. About the 1st of September, near the head and outside of the dredged cut, the steamer *City of St. Louis* went aground. As she was swung off she turned directly across the dredged cut, a shoal formed below her, and then the dredged channel rapidly deteriorated. It was seen that it would be necessary to abandon this locality and to select another cut to be dredged. This new location is shown on plate 47. On this plate the two sand bars shown are not the same as those illustrated on plate 43. This new location was a little below the position of the United States light shown on the last-named plate, and really cuts across what is there shown as a sand bar above low water. Plates 48, 49, and 50 show the very satisfactory results of the dredging at this locality.

Beiths Crossing (*366*).—Here the dredge *Gamma* opened a channel which was maintained and used during the rest of the low-water season.

Cypress Bend (*416*).—At no time was there less than 9 feet on this crossing, but before dredging it was difficult to run, as the channel was narrow and crooked. This narrow channel was widened and straightened, and no further difficulty was experienced at this point.

Mention has been made above of all of the localities where dredging was done during the low-water season of 1899. It is of interest to note that no dredging was necessary this season at Hathaways Crossing (104) and Island No. 40 (213), both of which had heretofore been difficult places, and that the good channels which existed at these localities occupied about the positions of the dredged cuts made in 1898. These instances afford some little evidence that where the dredged cuts do fill up during high water the filling is of a looser and less compact nature than at other places on the crossing, and that the river, during subsequent low-water periods, finds it easier to make its way through these cuts than elsewhere across the bars.

For additional details attention is invited to the report of Assistant Engineer C. W. Sturtevant (Appendix 2 G).

CENTRIFUGAL PUMPS.

Up to this date 6 dredges have been in use on the river below Cairo. Much information has been gathered as to the proper conduct of the dredging operations, but there is still a great deal to be learned.

One of the most vital parts of every dredge is the pump, and on these 6 dredges there are several different types of pump employed. It would seem that by now some definite conclusion as to the best type might have been reached. To properly test the efficiency of any two pumps, however, it would of course be necessary to employ them under precisely like conditions with similar suction heads and working

in similar material, while accurate measurements of the results would have to be made. No such tests have yet been practicable. It would be somewhat difficult to be sure that the conditions while testing were precisely the same, yet it seems evident that such tests would furnish valuable information, and that it would be well worth the time, trouble, and expense of making them when occasion serves.

There are some important facts about the pumps which have been developed and which are thought worthy of note.

Form of casing.—The different makers of pumps have adopted different forms of casings, some simple, others more or less complicated. Each maker has probably striven to adopt that form which would give the greatest efficiency. So far as can be determined from the field work of the dredges, in general, the form of casing has no very great effect upon the efficiency of the pump, so long as the runner blades fit the casing closely and the clearance between the blades and the casing is reduced to a minimum. As noted below, it seems necessary to provide renewable liners for the pump casings. These are much more easily attached and replaced when the casing is of a simple form and when curved surfaces on the interior are avoided. In other words, it seems best to make the cross section of the casing rectangular.

Wear of runners and casing.—The water, heavily loaded with sand, passes through the pumps at a high velocity. Although the ordinary river sand is not especially sharp, yet the wear upon both casing and runner is very rapid. In the dreding season of 1898, after less than one thousand hours' work, the casing of one of the pumps, over 2 inches thick, was worn entirely through, and the edges of the blades of the runner were worn almost an equal amount. This wear not only causes costly renewals or repairs, but also largely decreases the efficiency of the pumps, as noted below.

Effect of clearance between runners and casing.—It is evident from the nature of the pumps that any great amount of clearance between the runners and the casing will largely decrease their efficiency. To illustrate how great this decrease may be: On one of the dredges during last season the clearance at the beginning of the dredging was not more than one-eighth of an inch; after about six weeks' dredging the wear had been so great that this clearance was increased to nearly 1½ inches, and the efficiency of the pump was decreased by approximately 50 per cent. This would indicate the advisability of adopting some means of lessening or preventing the wear on the blades and casing in order that the maximum efficiency of the pump might be maintained.

Devices for compensating for and preventing wear.—The experience gained during the dredging season of 1898 showed the absolute necessity of providing easily renewable liners for the casings and of lessening the wear on both runners and liners if possible. Liners of hard cast iron and of steel plates were provided and bolted in place. It was expected that these would wear, but that they would protect the casing itself for at least one season. They answered their purpose well, but at the close of the last dredging season most of these liners were so far gone that they had to be replaced. To prevent the wear of the runner blades steel plates were bolted on the faces of these blades, and as the plates and casing liners wore the former were set out from time to time. Later, plates made of hard, tough rubber were employed instead of the steel plates on the liners. These rubber plates promise well. They wore but little and protected the blades themselves from all wear except a little on the under side, where the harm done was but slight. Experiments will probably be made to determine just what material will wear the least under the conditions which exist in these pumps. The indications at present are that hard steel plates for lining the casing and rubber plates on the blades will probably give good results. Inclosed runners closely fitting the casing will be tried on the dredges *Kappa* and *Henry Flad*.

Form of runner blades.—The sand and water entering the pump are carried around by the blades of the runner, and there is a tendency to flow off the edges of the blades and to be driven violently against the casing. In putting the plates on the blades during last season, they were in some cases held in place by iron straps put across the blades. These straps seemed to deflect the current of sand and water, and at the ends of the straps there was invariably a deep groove cut in the casing or in the lining. This indicates that the surface of the blade should be as smooth as possible, and that probably the best results would be obtained by giving to the face a slightly concave form; that if plates and straps are used the straps should run lengthwise of the blade and not across.

Form of suction head.—The different dredges have been fitted with suction heads of different forms. No comparative tests have been made to determine the best form of suction head. That this part of the pumping outfit will have quite an influence upon the efficiency of the machine there seems to be no doubt. It would be well to experiment with different suction heads attached to the same pump, and determine what form will give the best results.

EXPERIMENTAL DIKES.

At the date of my last annual report a plant was being collected and preparations were being made for beginning the field work when the river fell to the proper stage. Five dredges and a quarter boat were obtained from district officers. Two dredge pile sinkers were fitted up for the work. A steam tender and 5 barges were hired. Later, during the progress of the field work, another quarter boat and pile sinker were borrowed from the officer in charge of the improvement of the river between the mouth of the Missouri River and Cairo, Ill. Arrangements were made for securing the brush, poles, lumber, stone, wire strand, etc., needed in the construction of the dikes. After considerable preliminary study it was decided to begin field work in the vicinity of Point Pleasant (81), where some little work had been done during the previous season. Experience already gained had shown that this locality was not a favorable one for dike construction, yet it was one where a severe test of the dikes could be made and where the difficulties encountered would probably be greater than at any other point on the river. The result proved that these expected difficulties had not been overestimated.

The plant reached Point Pleasant on August 8, and dike construction was begun at once. A short distance above the sites selected for the dikes the river was vigorously attacking its right bank. The deflected current then struck the sand bar along which the dikes were afterwards placed, and it was caving rapidly. After passing this sand bar the water divided, some going to the left and some to the right of a dike put in position in 1898. A little below this last-named dike the current struck Bixby's towhead and again divided. The dikes were intended to check the caving of the bar, to promote the fill along its face, to close the channel to the left of the 1898 dike and Bixby's towhead. It was expected that, as these results were accomplished, the bar opposite the outer ends of the dikes would be cut away, that practically all of the water would pass to the right of the 1898 dike and of the towhead, and that a good straight channel would be made and maintained. The dikes, as located and built, are shown on plates 6–10. The one farthest upstream and the one farthest downstream, the latter entirely disconnected from the bar, were built in 1898. The intermediate dikes were built in 1899.

The details of construction are shown on plates 51 and 52. The triangular frames are set up on ways and held by longitudinal pieces. Screen poles were placed on the upstream side. Other poles were laid and wired on the bottom timbers of the frames. On these the rock ballast was placed. The height of the frames varied with the depth of the water, their tops being about the level of mean low water. The dikes were built on the ways in sections about 100 feet long. Anchor piles, with cables attached, were sunk a short distance above the dike and on a line parallel to it. The cables were attached to the dike, which, when launched from the barge, sunk into its place. The anchor piles were later broken off not less than 8 feet below mean low water.

The results of the work at Point Pleasant were not entirely satisfactory, but it was found that, even under the most unfavorable conditions, it was possible to put the dikes in position without undue loss and at a cost which was not excessive. The depth of water in which the dikes were placed was from 20 to 30 feet and the current over 6 feet per second. The caving of the bar at the shore ends of the dikes was stopped; the flow of water to the left of the 1898 dike was considerably lessened, and this channel became narrow and crooked; the channel to the left of Bixby's towhead closed; but little fill took place between the dikes; the bar opposite the outer ends of the dikes did not cut away as had been hoped. The absence of the expected fill is probably due to the fact that as the river fell the slope increased, and at about the lowest stage reached it was over nine-tenths of a foot per mile, a greater slope than at any other point on the river below Cairo. The current was exceedingly rapid and the amount of solid matter carried in suspension was quite small, the water being comparatively clear. Plate 10*a* shows the conditions at this locality, as determined by survey made on the 17th and 18th of May, 1900. Some fill has evidently taken place between the dikes, and it is probable that this material will remain in place while the river falls.

Work at Point Pleasant was completed on October 31. The plant was then moved to Cherokee Crossing. The dikes put in place at this locality are shown on plate 16. They were designed to close the deep blind channel along the right-hand shore, to build out the bar, and assist in maintaining the navigable channel over this wide, flat crossing. Conditions here were much more favorable than at Point Pleasant. The current was not so rapid and the depth of water in which the dikes were placed was much less. The results of the work were very satisfactory. The right-hand shore blind channel was much reduced in width and in depth in the vicinity of the

dikes, considerable fill took place below the dike, and the channel was deepened near the outer end of the longer and upstream dike. That the opposite bar did not cave was partly due to an underlying stratum of gravel which the current could not move. Plate 16a shows the conditions at this locality, as determined by survey made on May 19, 1900. The blind channel along the bar has been practically closed, and considerable fill has taken place above and below the dikes, which seem here to have done the work which they were expected to accomplish.

During the season of 1899, 8,920 linear feet of dike were built at a field cost of $4.38 per foot. This cost is high on account of the difficulties met with at Point Pleasant and of the comparatively large sum which had to be expended for the hire of plant. The average number of men employed was 91, and the average length of the dike built per day was 97 linear feet.

In my opinion, dikes of the type employed may, under favorable conditions, give satisfactory results and at a comparatively low cost. They should probably not be employed where the depth of water is greater than 12 to 15 feet, nor in the swift currents, such as were encountered at Point Pleasant. To accomplish the desired results during the season in which they are put in place the dikes must be built rapidly. This necessitates a large plant and a large working force. There are few places along the river below Cairo where dikes could be advantageously employed that the length of dikes to be built would be less than 3,000 feet; at most places even greater lengths might be required. With a plant similar to that employed during last season, and under reasonably favorable conditions; this means that at each locality it will be necessary to do at least thirty days' work. During the usual working season a single plant could therefore be employed at not more than two or three different places. Localities should be selected where no very radical changes are likely to take place for some time and where the good results secured any one year will probably endure during several succeeding seasons of low water.

For additional details of construction, attention is invited to report of Assistant Engineer William Gerig (Appendix 2 H).

COMMERCIAL STATISTICS.

It is practically impossible to obtain reliable statistics of the commerce on the Lower Mississippi River unless special agents are employed for their collection.

The following papers accompany this report:

Money statement.

Abstracts of all proposals, in order of date of opening bids.

Abstracts of contracts in force, with names of contractors, dates of approval, of beginning work, and of expiration.

Statement of charts issued and sold.

List of civilian engineers.

Approximate value of plant.

Appendix 2 A, Laws affecting the Mississippi River Commission, July 1, 1899, to June 30, 1900.

Appendix 2 B, Specifications for the construction of the dredges *Kappa* and *Henry Flad*.

Appendix 2 C, Specifications for the construction of refrigerating plants.

Appendix 2 D, Report of Assistant Engineer A. T. Morrow, on survey work and reconnaissance north of St. Paul, Minn.

Appendix 2 E, Report of Surveyor W. S. Williams on precise level work of 1898 and 1900 below Fort Adams, Miss.

Appendix 2 F, Report of Assistant Engineer Kivas Tully on gauges, reduction of physical data, office records and publications.

Appendix 2 G, Report of Assistant Engineer C. W. Sturtevant on care and repair of plant, and dredging operations.

Appendix 2 H, Report of Assistant Engineer William Gerig on experimental dike work.

Respectfully submitted.

MASON M. PATRICK,
Captain, Corps of Engineers,
Secretary Mississippi River Commission.

Col. G. L. GILLESPIE,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

Money statement.

July 1, 1899, balance unexpended		$1,264,955.66
June 30, 1900, amount expended during fiscal year		602,171.46
July 1, 1900, balance unexpended		662,784.20
July 1, 1900, outstanding liabilities	$27,198.77	
July 1, 1900, amount covered by uncompleted contracts	309,935.88	
		337,134.65
July 1, 1900, balance available		325,649.55
Amount that can be profitably expended in fiscal year ending June 30, 1902		550,000.00

Abstract of proposals for furnishing coal for dredging operations, received in response to advertisement dated the 22d day of January, 1900, and opened by Capt. Mason M. Patrick, Corps of Engineers, on the 21st day of February, 1900.

No.	Name of bidder.	Kind of coal; name and location of mine.	Quantity.	Price per bushel.	Total cost.
			Bushels.	*Cents.*	
1	The Monongahela River Consolidated Coal and Coke Co., Pittsburg, Pa.	Pittsburg district mines at points on the Monongahela River adjacent to Pittsburg, Pa.	350,000	13.96	$48,825
2	Frederick Hartweg, Cincinnati, Ohio.	Catsburg and Rostraber mines on Monongahela River, Chesapeake mines at Handley, W. Va.; Coalburg mines at Coalburg, W. Va.; Cedar Grove mines at Cedar Grove, W. Va., and Belmont mines at Belmont on Kanawha River, W. Va.	350,000	14	49,000

All bids rejected.

Abstract of proposals for furnishing refrigerating plants for tenders Sachem, Choctaw, Wynoka, Nokomis, and Leota, and dredge Iota, used in dredging operations under Mississippi River Commission, received in response to advertisement dated January 29, 1900, and opened by Capt. Mason M. Patrick, Corps of Engineers, on February 28, 1900.

No.	Name of bidder.	Price for one plant.	Total cost for six plants.	Remarks.
1	Memphis Machine Works, Memphis, Tenn.	$2,190.00	$13,140	Accepted.
2	Atlanta Machine Works, Atlanta, Ga.	3,287.50	19,725	
3	Creamery Package Manufacturing Co., Chicago, Ill.	2,799.00	16,794	For vertical single-acting two-pump compressor.
	....do	2,600.00	15,600	Alternate proposal No. 1, for single-pump compressor.
	....do	2,490.00	14,940	Alternate proposal No. 2, for horizontal style double-acting Barber compressor.
4	Charles A. McDonald, Chicago, Ill...	4,050.00	24,300	
5	The De La Vergne Refrigerating Machine Co., New York, N. Y.	5,500.00	33,000	
6	Remington Machine Co., Wilmington, Del.	3,150.00	18,900	With tight covers for tanks and ice molds.
	....do	2,950.00	17,700	Without tight covers for tanks and ice molds.
7	Newburg Ice Machine and Engine Co., Newburg, N. Y.	3,800.00	22,800	
8	The Healy Ice Machine Co., Chicago, Ill.	4,000.00	24,000	
9	Frick Co., Waynesboro, Pa	3,329.17	19,975	
10	Kroeschell Bros. Ice Machine Co., Chicago, Ill.	3,530.00	21,180	
11	The Fred W. Wolf Co., Chicago, Ill ..	3,564.00	21,384	
12	York Manufacturing Co., York, Pa ...	3,410.00	20,460	
13	Ice and Cold Machine Co., St. Louis, Mo.	3,333.00	19,998	
14	Henry Vogt Machine Co., Louisville, Ky.	2,050.00	12,300	Absorption system.

Abstract of proposals for furnishing 178 steel pontons for dredges used in dredging operations on the Mississippi River under the Mississippi River Commission, received in response to advertisement dated February 19, 1900, and opened by Capt. Mason M. Patrick, Corps of Engineers, on March 21, 1900.

No.	Name of bidder.	18 for dredge Beta (each).	80 for dredge Gamma (each).	80 for dredge Delta (each).	Total cost.
1	John O'Brien Boiler Works Co., St. Louis, Mo	$597.00	$84.00	$254.00	$37,786.00
2	Jos. F. Wangler Boiler and Sheet Iron Works Co., St. Louis, Mo	321.52	58.86	160.04	23,259.36
3	Iowa Iron Works, Limited, Dubuque, Iowa	a 131.37	40.40	91.27	12,898.26
4	Charles Hegewald Co., New Albany, Ind	199.50	35.90	99.00	14,383.00
5	Wm. B. Scaife & Sons, Pittsburg, Pa	182.00	35.05	117.00	15,680.00
6	The Springfield Boiler and Manufacturing Co., Springfield, Ill	150.72	38.31	99.81	13,522.56
7	Littleford Bros., Cincinnati, Ohio	185.00	40.00	132.00	17,090.00
8	Koken Iron Works, St. Louis, Mo	184.36	41.14	97.25	14,389.68
9	Joliet Bridge and Iron Co., Joliet, Ill	220.00	44.80	114.50	16,704.00
10	New Jersey Foundry and Machine Co., New York, N. Y	136.30	a 29.80	81.02	11,319.00
11	Lee-Odlum Boiler Co., Memphis, Tenn	152.49	33.78	82.65	12,059.22
12	Henry Vogt Machine Co., Louisville, Ky	142.66	31.78	a 72.68	10,921.68
13	National Boiler Works, Chicago, Ill	204.79	45.00	104.41	15,639.08
14	Ed. J. Howard, Jeffersonville, Ind	.....	.....	205.00	.....
15	M. A. Sweeny Ship Yard and Foundry Co., Jeffersonville, Ind	279.80	54.49	149.49	21,354.80
16	Warren City Boiler Works, Warren, Ohio	20.07	48.06	110.97	13,083.66
17	Wabash Bridge and Iron Works, Wabash, Ind	165.00	46.00	95.00	14,250.00

a Accepted.

Abstract of proposals for furnishing eight steel boilers for pile sinkers used in dredging operations on the Mississippi River under the Mississippi River Commission, received in response to advertisement dated May 24, 1900, and opened by Capt. Mason M. Patrick, Corps of Engineers, on June 23, 1900.

No.	Name of bidder.	Price for 1 boiler.	Total cost for 8 boilers.	Remarks.
1	Henry Vogt Machine Co., Louisville, Ky	$500.00	$4,000.00	Recommended for award.
2	M. M. Buck Manufacturing Co., St. Louis, Mo	550.00	4,400.00	
3	Jos. F. Wangler Boiler and Sheet Iron Works Co., St. Louis, Mo.	645.50	5,164.00	
4	Burhorn & Granger, New York, N. Y	719.25	5,754.00	

Abstract of contracts entered into by Capt. Mason M. Patrick, Corps of Engineers, in force June 30, 1900.—Improving Mississippi River, Mississippi River Commission, secretary's office.

Contract for—	Contractor.	Date of contract.	Date of approval.	Date of beginning work.	Date of expiration of contract.
Self-propelling dredge Iota.	The Springfield Boiler and Manufacturing Co.	Aug. 26, 1898	Nov. 14, 1898	Sept. 5, 1898	Aug. 26, 1899, extended to Aug. 1, 1900.
Coal	Frederick Hartweg.	Apr. 27, 1899	July 8, 1899	July 1, 1899	June 30, 1900, extended to Aug. 31, 1900.
Self-propelling dredges Kappa and Henry Flad.	The Bucyrus Co	June 14, 1899	Oct. 2, 1899	Oct. 6, 1899	July 1, 1900, extended to Jan. 1, 1901.
Supplemental for self-propelling dredge Iota.	The Springfield Boiler and Manufacturing Co.	July 1, 1899	July 26, 1899	Aug. 1, 1899	Aug. 26, 1899, extended to Aug. 1, 1900.
Six refrigerating plants.	Memphis Machine Works.	Mar. 29, 1900	May 24, 1900	Apr. 8, 1900	Aug. 1, 1900.

Statement of maps and charts issued and sold from July 1, 1899, to June 30, 1900.

Description.	Free.	Sold.	Total.
Upper alluvial valley map	681	50	731
Lower alluvial valley map	1,386	293	1,679
Inch-to-mile map	877	901	1,778
Detail chart, 1: 20,000 scale	1,738	230	1,968
Detail chart, 1: 10,000 scale (harbor of New Orleans)	.....	56	56
District map of Lower Mississippi River	2	5	7
Total	4,684	1,535	6,219

Proceeds deposited with assistant treasurer of the United States at St. Louis, Mo., $166.31.

List of civilian engineers employed on works of the Mississippi River Commission in charge of the secretary from July 1, 1899, to June 30, 1900.

Name and residence.	Time employed.	Pay per month.	Where employed.	Work on which employed.
	Months.			
Thomas Middleton, St. Louis, Mo	12	$225	Secretary's office	In charge of designing and construction of plant.
C. W. Sturtevant, Appleton City, Mo	12	200	In field	In charge of dredging operations.
A. T. Morrow, Rockford, Ill	12	175	In field and secretary's office.	Surveys.
Kivas Tully, St. Louis, Mo	12	175	Secretary's office	Computing division.
C. W. Clark, Webster Groves, Mo	12	175	do	Mapping division.
E. H. Twining, New York, N. Y	12	175	President's office	Reports and estimates.
W. G. Comber, St. Louis, Mo	12	150	In field and secretary's office.	Surveys.
Geo. H. French, St. Louis, Mo	12	145	do	Do.
Wm. Gerig, New Orleans, La	12	150	In field	Experimental dikes and dredging.

Approximate value of plant belonging to the United States used on works under the Mississippi River Commission, in charge of Capt. Mason M. Patrick, Corps of Engineers, secretary, June 30, 1900.

Class of property.	Present approximate value.	Class of property.	Present approximate value.
Dredge Alpha	$43,740	Steamboat Search	$6,300
Dredge Beta	229,864	Steamboat Vulcan	7,080
Dredge Gamma	74,384	Steamboat Mercury	7,749
Dredge Delta	96,814	Steamboat Venus	7,749
Dredge Epsilon	89,775	Steamboat Mars	7,749
Dredge Zeta	89,775	5 barges	4,050
Steamboat Mississippi	40,500	7 pile sinkers	13,038
Towboat Minnetonka	9,720	3 survey and quarter boats	2,476
Towboat Sachem	45,672	Flatboats, yawls, and rowboats	983
Towboat Choctaw	45,672	Diving outfit	270
Towboat Wynoka	45,672	Surveying instruments, photographic outfit, office furniture, books, etc	8,028
Towboat Nokomis	45,672		
Towboat Leota	45,672		
Steamboat Patrol	8,100	Total	975,504

APPENDIXES ACCOMPANYING THE REPORT OF CAPT. MASON M. PATRICK, CORPS OF ENGINEERS, SECRETARY MISSISSIPPI RIVER COMMISSION.

A. Laws affecting the Mississippi River Commission, July 1, 1899, to June 30, 1900.

B. Specifications for the construction of self-propelling dredges *Kappa* and *Henry Flad*.

C. Specifications for the construction of refrigerating plants for dredge *Iota* and large tenders.

D. Report of Assistant Engineer A. T. Morrow on survey work and reconnaissance north of St. Paul, Minn., season of 1899.

E. Report of Surveyor W. S. Williams on precise level work of 1897–98 and 1900, below Fort Adams, Miss.

F. Report of Assistant Engineer Kivas Tully on gauges, reduction of physical data, and office publications.

G. Report of Assistant Engineer C. W. Sturtevant on dredging operations on the Mississippi River between Cairo, Ill., and Head of the Passes, La.

H. Report of Assistant Engineer William Gerig on experimental dike work.

LIST OF PLATES ACCOMPANYING THE ANNUAL REPORT OF CAPT. MASON M. PATRICK, CORPS OF ENGINEERS, U. S. A., SECRETARY MISSISSIPPI RIVER COMMISSION, FOR FISCAL YEAR ENDING JUNE 30, 1900.

PLATE 1.—Map of New Madrid Bend, showing location of ranges of scour and fill survey and discharge section of 1899.
PLATE 2.—Low-water profile, Mississippi River, Cairo to Fort Jackson, 1899.
PLATE 3.—Hydrograph, Mississippi River, Cairo to Fort Jackson, June 1, 1899, to May 31, 1900.
PLATE 4.—Comprehensive hydrograph, Mississippi River and its principal tributaries, 1871 to 1899, inclusive.
PLATE 5.—Flood discharges of the Mississippi River below Cairo, 1851 to 1899.
PLATES 6–50.—Maps of certain localities below Cairo where dredging was done during low-water season of 1899, as follows:
6–10 A.—Point Pleasant Crossing; showing also experimental dikes.
11–16 A.—Cherokee Crossing; 16–16 A show also experimental dikes.
17–21.—Hickman Crossing.
22.—Gold Dust Crossing.
23–27.—Luxora Crossing.
28–31.—Vicinity of Osceola, Ark.
32–36.—Upper Crossing, Island No. 34.
37–42.—Presidents Island Bar.
43–50.—Fleeces Crossing.
PLATES 51–52.—Detail drawings of experimental dikes at Point Pleasant, Mo., and Stewarts, Mo. (Cherokee).

APPENDIX 2 A.

LAWS AFFECTING THE MISSISSIPPI RIVER COMMISSION, JULY 1, 1899, TO JUNE 30, 1900.

[PUBLIC—No. 163.]

AN ACT Making appropriations for sundry civil expenses of the Government for the fiscal year ending June thirtieth, nineteen hundred and one, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums be, and the same are hereby, appropriated, for the objects hereinafter expressed, for the fiscal year ending June thirtieth, nineteen hundred and one, namely:

* * * * * * *

UNDER THE WAR DEPARTMENT.

* * * * * * *

ENGINEER DEPARTMENT.

* * * * * * *

The Secretary of War is hereby authorized and empowered, in his discretion, in case any unusual obstruction to navigation in the channel of South Pass, Mississippi River, should occur during the fiscal year nineteen hundred and one, to use any

dredges or tugboats of the Mississippi River Commission for the purpose of removing the same. And the sum of twenty-five thousand dollars, or so much thereof as may be necessary, is hereby appropriated, to be expended in the discretion of the Secretary of War in improving or altering such dredge or dredges so as to make the same available for use in said South Pass.

* * * * * * *

MISSISSIPPI RIVER.

Improving the Mississippi River: For continuing improvement of Mississippi River from Head of the Passes to the mouth of the Ohio River, including salaries and clerical, office, traveling, and miscellaneous expenses of the Mississippi River Commission, two million two hundred and fifty thousand dollars.

* * * * * * *

Approved, June 6, 1900.

[PUBLIC—No. 162.]

AN ACT Making provision for emergencies in river and harbor works, for certain surveys, and for the diversion of certain appropriations or modification of provisions heretofore made.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

* * * * * * *

KENTUCKY AND TENNESSEE.

The east bank of the Mississippi River between the highlands near the city of Hickman, in the State of Kentucky, and Slough Landing, in Lake County, in the State of Tennessee, with a view to constructing such works as may be required to prevent overflows along said section of the river, such examination and survey to be made under the direction of the Mississippi River Commission, the cost thereof to be paid out of the unexpended balance authorized to be expended by said commission.

* * * * * * *

Approved, June 6, 1900.

APPENDIX 2 B.

SPECIFICATIONS FOR THE CONSTRUCTION OF SELF-PROPELLING HYDRAULIC DREDGES KAPPA AND HENRY FLAD FOR MISSISSIPPI RIVER COMMISSION.

SPECIAL CONDITIONS.

34. General.—The work to be contracted for under these specifications is the building of the hulls, cabins, dredging and propelling machinery of two (2) self-propelling hydraulic dredges, together with such parts and appurtenances for each dredge as are hereinafter described, and shall comprise all the materials, tools, labor, etc., of every description requisite and necessary for the proper and entire completion and delivery of the same. These specifications refer to and describe but one dredge; it must be understood that both dredges are to be built precisely alike in all particulars.

35. Proposals.—Proposals will be received for one or two dredges complete as hereinafter described. The right is reserved to accept or reject any or all bids or parts thereof and to make award as may be deemed most advantageous to the United States.

36. Bidders' and contractor's drawings, etc.—Bidders must submit with their proposals such drawings in triplicate as will illustrate the machinery which they propose

to furnish and which do not form part of the drawings supplied by the United States; more particularly those of the main engines, side-wheel engines, condenser and air pump, and jet pump; and also a general plan of the refrigerating plant; together with specifications in triplicate giving full description of the above parts. A copy of these specifications should be attached to each copy of the proposal and be referred to therein. The drawings need not be attached to the proposal, but should be referred to therein. The successful bidder will be required to furnish seven (7) copies of these drawings and specifications to complete the contract. The contractor must also submit to the engineer officer in charge for approval any and all working drawings that may be required in the prosecution of the work that are not furnished by the United States. A complete set of the tracings of these working drawings must also be furnished and delivered at the office of the secretary Mississippi River Commission, St. Louis, Missouri, upon completion of work and prior to the final payment.

37. Quality of material.—Except it be otherwise specified, all the materials are to be of the best quality of their respective kinds, and all labor is to be done in a most thorough, prompt, and workmanlike manner to the full satisfaction of the engineer officer in charge. In all cases where an article is mentioned, preceded or followed by the words "or equal," "best quality," "approved quality or make," or "or other equally good," or words of like purport, the engineer officer in charge will decide as to the best and most suitable article to be used.

38. Inspection.—Inspectors will be appointed by the United States to supervise the work, and the contractor must at all times give them access to the work and full facilities for examination of all material and workmanship. Such tests of material as are deemed necessary are to be made at the expense of the contractor under the supervision of the inspectors. The engineer officer in charge shall have the right to require the immediate removal of any employé of the contractor who is deemed incompetent or otherwise objectionable.

39. Extra work.—It is the intent of these specifications to secure to the United States a dredge of first-class construction, complete in all respects for the work it is designed to do, and ready for operation. No claim whatever shall at any time be made upon the United States by the contractor for or on account of any extra work or materials performed or furnished, or alleged to have been performed or furnished, unless such extra work or materials shall have been expressly required in writing by the engineer officer in charge, the prices and quantities thereof having been first agreed upon by the contracting parties and approved by the Chief of Engineers.

40. Patents.—The contractor shall guarantee the Government against any claims or awards for damage on account of the infringement of any patented devices which he shall furnish the dredge.

41. Omissions, etc.—All necessary adjuncts, parts, or attachments properly forming a part of a dredge and requisite for the proper and efficient working of the machinery shall be understood to be included in these specifications, whether mentioned herein or not, and shall be supplied by the contractor as forming part of the contract. Any doubt as to the meaning of these specifications, or of any drawings or explanations which are furnished the contractor, will be explained by the engineer officer in charge, who shall also have the right to correct any errors in said specifications, etc., when such correction is necessary for the proper fulfillment of their intention.

42. Delivery.—The dredge must be completed in every part and delivered to the engineer officer in charge at Cairo, Illinois, for test, on or before the first (1st) day of July, 1900. Upon notification being received that the dredge is ready for delivery, the engineer officer in charge will direct a preliminary inspection to be made to determine whether everything is complete and in proper working order, and the tests will not be proceeded with unless all parts of the dredge plant, tools, and accessories are deemed by said engineer officer in charge to be practically complete in accordance with the terms of these specifications. Delivery for test will not be deemed accomplished, however, until the completion in a satisfactory manner of the contractor's test prescribed below. If there be no delay caused by defective material or bad workmanship during the subsequent Government test, beyond that hereinafter authorized, the date of the commencement of this Government test will be considered as the date of the delivery of the dredge. Should, however, there be delays from the above causes, the date of delivery will be taken as that on which a successful Government test is begun. The dredge will not be accepted for Government test until the engineer officer in charge deems the stage of water and condition of weather suitable for said test.

43. Penalty.—In case of failure to complete and deliver the dredge within the time specified, the contractor will be liable and must pay any and all expenses incurred by the United States because of said failure, said expenses to be determined by the engineer officer in charge.

44. Contractor's test.—When the preliminary inspection is satisfactorily completed, the contractor will be required, before beginning the Government test, to make an endurance test of his own. This will consist in running the main engines and pump at a velocity of 155 revolutions per minute, during a continuous period of ten (10) hours while pumping water through 500 feet of discharge pipe, the other machinery being run at the same time at its full working speed. Before this test the dredge will be moved to such point in the river near Cairo, Illinois, as the engineer officer in charge may select, and will remain anchored by the spud during test This test must be run at the sole expense of the contractor. During the same full records of the running of all machinery will be taken by the authorized agents of the engineer officer in charge, but the contractor will have full control of the working of all machinery. Should this test not be successful, other tests on the same plan must be made until the machinery will satisfactorily perform the requirements.

45. Government test.—After the dredge is accepted for test, the Government efficiency test will be made under the direction of the engineer officer in charge, with his own employés. This test will consist in operating the dredge under actual working conditions, with the main engines and pump running at about 140 revolutions per minute, and all the other machinery at the requisite working capacity, for a period of five (5) days, either continuously night and day or for any less period, at the option of the engineer officer in charge. During this test the pipe line may be increased to 1,000 feet and capacity tests taken and the dredge maneuvered in any way the engineer officer in charge may deem advisable, but the main engines will not be run above 155 revolutions, the steam pressure carried will not exceed 170 lbs. per square inch, and the dredge will not be forced into the cut beyond a fair working speed according to the face of bank ahead. Full records of this test will be taken and the time of stoppages for repairs due to defective material or bad workmanship must not exceed fifteen (15) per centum of the time spent in actual dredging. Any minor repairs needed during this test which can be done on board will be done at the expense of the United States, but the cost of all other repairs must be borne by the contractor. During the Government test the contractor and his authorized representatives will be taken care of aboard the dredge, but will not be allowed to give any orders to any of the crew without the consent of the agent of the United States in charge.

46. Towing test.—To test the working of the propelling engines the dredge will make a trip of four (4) hours' duration upstream and return, with one pile sinker, one coal barge partially loaded, and all the pipe line in tow. The engines will be run full speed with various rates of cut-off and full records taken.

47. Other tests.—If the Government efficiency test above described proves unsatisfactory, the engineer officer in charge may continue the tests for such period as he may find advisable in order to obtain the desired results.

48. Final inspection.—Immediately after the conclusion of the tests all parts of the dredge plant furnished by the contractor will be given a thorough examination under the direction of the engineer officer in charge; and if any repairs are found necessary to the machinery which are not properly chargeable to fair wear and tear, the contractor will be required to put the same in proper working order. He will also complete the painting and turn over the drawings as specified in paragraphs 179 and 36. The engineer officer in charge may, however, if he deems advisable, waive these requirements and accept the dredge, deducting from the contract price sufficient to cover the cost of making good any deficiencies determined by the final inspection.

49. Payments.—When the hull is finished, wheel beams, bridge trees, and cylinder beams in place, ready for machinery, and said hull successfully launched, twenty (20) per centum of the contract price will be paid. After the launching and the payment of the twenty (20) per centum, monthly payments may be made on estimates of the engineer officer in charge or his authorized agents of the value of the work completed and in place. Twenty (20) per centum of the contract price will be retained until after the testing, final inspection, and acceptance of the dredge, to cover the cost of any alterations or deductions found necessary.

50. Ownership.—All parts paid for under the system of partial payments above specified shall become thereby the sole property of the United States, but this provision shall not be interpreted as relieving the contractor from the sole responsibility for the proper care and protection of said parts prior to delivery of the dredge to the United States, or from any other of the provisions of these specifications.

DETAILED SPECIFICATIONS.

51. Description.—This dredge is designed to have a single sand pumping outfit and also to be self-propelling. The hull is to be of steel throughout, with guards extending to outside of paddle boxes, the knuckles rounded, the bow and stern to be made

with long rakes, the usual suction well to be built in bow and towing knees at head, and is estimated to have a draft of 48 inches when fully equipped. The pumping machinery will consist of a centrifugal pump with 32-inch discharge pipes, and will be capable of delivering not less than 1,000 cubic yards of sand per hour through 1,000 feet of pipe under average field conditions. This pump will be driven by a pair of horizontal tandem compound condensing engines, good for running at 155 revolutions per minute. The sand agitator will be of the water-jet type, supplied with water at pressure ranging from 60 to 120 lbs. per square inch, by a duplex compound plunger pump. The feeding into cut will be done by wire rope haulage similar to that adopted for all dredges of the Commission. The propelling machinery will consist of two side paddle wheels, each 22 feet in diameter and 13 feet long, driven by engines of the Mississippi River type. The steam plant will consist of seven Mississippi River four-flued boilers set in three batteries, and built for a working pressure of 170 lbs. per square inch. The condenser and air pump will be of the independent type, and the dredge will be provided with steam steering apparatus and all accessories for working both as a dredge and a steamboat.

52. Drawings.—The drawings furnished by the United States are those prepared in the office of the secretary Mississippi River Commission, and are indexed and catalogued as $\frac{\text{M. R. C.}}{1051}$. The numbers and titles of the sheets are as follows:

Sheet 1. Lines of hull.
Sheet 2. Longitudinal section.
Sheet 3. Main deck plan.
Sheet 4. Boiler deck plan.
Sheet 5. Cross sections.
Sheet 6. Details of hull.
Sheet 7. Wheel beams and bridge tree.
Sheet 8. Cylinder beams.
Sheet 9. Paddle boxes.
Sheet 10. Main pump.
Sheet 11. Suction heads.
Sheet 12. Radial joints for suction.
Sheet 13. Hoisting frame.
Sheet 14. Swivel elbow for discharge.
Sheet 15. Hauling winches.
Sheet 16. Steam spud lift.
Sheet 17. Hydraulic tubular piles.

HULL.

53. General dimensions.—

Length molded	192′	0″
Width molded	44′	0″
Depth molded	7′	0″
Width at bow	32′	0″
Width at stern	34′	0″
Width over guards outside of nosing	75′	0″
Length of well	33′	0″
Width of well at nose	25′	0″

54. Framing.—The dredge is to be framed on the transverse system, with six transverse bulkheads, two collision bulkheads in wings, and four longitudinal truss frames. The frames are numbered from the bow, which is zero, to the transom, which is No. 128, and will be referred to in these specifications by these numbers. The frames are spaced at a uniform distance apart of 18 inches. The even-numbered frames from 26 to 108, inclusive, are of 2½ in. × 2½ in. × 5 lb. angle bars, with floor plates 8 inches wide and $\frac{5}{16}$ inch thick riveted to the standing flange, on the top edges of which reverse frames of 2½ in. × 2½ in. × 5 lb. angle bars are riveted extending up the turn of bilge to a vertical height of 30 inches from bottom. The odd-numbered frames from 27 to 109, inclusive, and all frames in bow wings and stern rake are of 3 in. × 2½ in. × 5.5 lb. angle bars. All floor frames are to butt on the center line of hull and will be connected by splice plates and angles at least 18 inches long. The bulkheads take the place of the frames for which they are numbered.

55. Deck beams.—From frame No. 24 to No. 126, inclusive, the even-numbered deck beams are of 6 in. × 15.6 lb. Z bars, and the alternate beams are of 3 in. × 2½ in. × 5.5 lb. angle bars; the short beams at bow wings being also of 3 in. × 2½ in. × 5.5 lb. angle bars. Deck beams No. 22, crossing end of well, and No. 128, at transom, are of 4 in. × 4 in. × 12.8 lb. angles. Each deck beam is attached to its corresponding frame

by gussets, those for Z bars being 21 in. × 36 in. × ½ in., and those for angle bars being 12 in. × 12 in. × $\frac{5}{16}$ in.

56. *Transverse bulkheads.*—The collision bulkheads are on frame No. 10, and the transverse bulkheads are on frames Nos. 32, 46, 62, 78, 90, and 110, respectively. They are all to be water-tight and are made of 7.65 lb. plate riveted to floor and deck beams and stiffened by 2 in. × 2 in. × 3.2 lb. angle bars placed alternately on opposite sides of bulkheads at a distance of about 24 inches apart. The joints of plates are to be double-riveted lap. The collision bulkheads are to have manholes strengthened by an iron ring and provided with a water-tight door and also a 2½-inch gate valve for draining the compartments.

57. *Longitudinal truss framing.*—The side plating of well will be continued to bulkhead No. 32, and the inboard truss frames will then commence and run aft to transom, maintaining the line of well sides until they meet bulkhead No. 46, at which point they are 5½ feet each side of center line, and are continued parallel throughout the remainder of their length. The outboard trusses will run from bulkhead No. 32 to transom at a distance of 14 feet from center line. The top and bottom chords are to be made of two 2½ in. × 2½ in. × 5 lb. angles and 10.2 lb. web plates 10 inches wide, riveted to each 8-inch floor and all deck beams, and in addition by clips of 2½ in. × 2½ in. × 5 lb. angles, and such other suitable sizes as are required. The chords will pass through the transverse bulkheads intact and be made water-tight by the angle connections. Lattice bracing in double panels made of 2½ in. × 2½ in. × 5 lb. angles will be worked in between transverse bulkheads, as shown on sheet 6. The after ends of trusses will be attached to transom by double angles 2½ in. × 2½ in. × 5 lb.

58. *Gunwales.*—The gunwales are to be of 3 in. × 3 in. × 7.2 lb. angle to be riveted on outside of sheer strake and will extend continuously from bow to stern.

59. *Hull plating.*—The bottom of hull will be plated with 10.2 lb. plate, except keel strake and rake of bow wings, which will be of 12.75 lb. plates; the bilge strake or knuckle will be of 12.75 lb. plate throughout; the sheer strake will be 12.75 lb. between frames No. 20 and 116, and 10.2 lb. at the ends; the side plating of hull and well will be 10.2 lb; the end of well will be 20.4 lb. in one plate, and the rake of well 12.75 lb. plate. The seams of keel strake will be double riveted, and all other seams will be single riveted, and all butts will be double riveted. The bottom plating will be in 13 strakes laid alternately inside and outside, the keel strake being on the outside. The width of bottom strakes will be 36 inches center to center of laps and the ruling length of plates will be 18 feet. All butts will be planed and fitted close metal to metal. But straps must be $\frac{1}{16}$ inch thicker than the plates which they connect, and must be fitted close between the edges of inside strakes. Solid liners in one length must be fitted at every frame between frame and outside strake of plating. The liners must be the full width of the flange of frame to which they are fitted except in the way of water-tight bulkheads, where they will extend in one piece from the fore edge of the frame before to the after edge of the frame abaft the bulkhead.

60. *Deck plating.*—To be in 15 strakes, each 36 inches wide center to center of laps, except the plate sheer, which must be of the requisite width to project 2½ inches outside of gunwale angle except between the wheel beams, where it will be flush. The plate-sheer will be of 12.75 lb. plate for the length amidship between frames Nos. 34 and 112, and all the remainder of deck will be of 10.2 lb. plate. The deck will be level throughout, without sheer or crown, and will be laid alternately inside and outside strakes; and all seams, butts, butt-straps and liners will be similar to those specified above for the hull plating, the center strake being an outside strake.

61. *Riveting, etc.*—Rivets are to be of soft steel or Burden's best, and ⅞ inch in diameter throughout the hull, except where otherwise specified or noted on drawings or the nature of the work requires a different size. The rivets in seams and butts of outside plating will be spaced not more than 2½ inches apart center to center, and rivets in seams of all internal water-tight work will be spaced not more than 2¾ inches centers. All double riveting will be chain fashion except where otherwise noted on drawings. The distance from center to center between the rows will be 1⅝ inches. No rivet will be nearer the seam, butt, or edge of plate or angle bar than its diameter. Spacing of rivets in beam knees will be from 2¾ to 3½ inches centers, but no beam knee will be secured to its frame with less than four (4) rivets. Rivets for securing outside plating to floors and frames, stiffening angle bars to bulkheads, and for all work where angle bars do not require to be calked, will be spaced not more than 5 inches centers. Heavy drifting must not be resorted to, and holes not punched fair must be reamed fair and a size of rivet to fit the hole must be used. Countersinks must be not less in depth than three-fourths the thickness of the plate or angle bar countersunk. Rivets will completely fill their holes, the heads will be laid up in all water-tight work, and the points of rivets when finished will com-

pletely fill the countersinks and be flush or slightly convex with the surface of plates.

62. Guards.—The guards will extend the full length of hull, of the form and dimensions shown on sheet 3. The wheel beams are to be opposite to bulkheads Nos. 62 and 78 and are to be 24 feet apart, center to center, projecting 14 ft. 9 ins. from hull, with a landing of 28 inches on side plating. They will consist of 3 in. × 3 in. × 7.2 lb. angles doubled, for top and bottom chords, with webs of 10.2 lb. plate, and will be further secured to deck by gusset plates, and the outer ends built into bridge trees. The outriggers next to wheel beams will be of similar construction, but with single angle bars and 7.65 lb. plate. Diagonal braces of 5 in. × 2½ in. × 11 lb. T bar will be riveted to under plate sheer at ends of wheel beam and extend to hull, as shown on sheets 3 and 7, and riveted to all the outriggers they cross. Fore and aft from these the outriggers will be made with two chords of 2½ in. × 2½ in. × 5 lb. angles, tied together by bars of 2 in. × 2 in. × 3.2 lb. angles and gusset plates, and attached to nosing plate by 3-inch angle clips. Towards the bow, where the guard narrows, the bottom chord can be omitted and gusset plates used. The outriggers will be spaced 36 inches apart and coincide with the even numbered frames, and have a rise at the outer end of 8 inches at the widest part. The guards fore and aft of paddle boxes will be decked with 7.65 lb. plate, which will be riveted on the under side of plate sheer and to all the outriggers. Between each outrigger the deck will be stiffened by 2 in. × 2 in. × 3.2 lb. angle bars at intervals of about 36 inches. Scupper holes 1½ inch diameter will be made at intervals all along the guard at edge of deck plating.

63. Bridge trees.—These will be box girders built on the ends of wheel beams, and will consist of top plate 15 inches wide by 12.75 lb., two web plates 8 inches deep by 12.75 lb., four angles 3 in. × 3 in. × 7.2 lb., and lattice bracing on bottom as shown on sheet 7. On the center of bridge tree is built the bolster for outboard bearing of paddle shaft, the top chord angles to be 4 in. × 4 in. × 9.8 lb., which will be carried down and secured to bridge tree as braces. The height and size of bolsters may be modified to suit the requirements of engine builder.

64. Wheel-beam chains.—The outer ends of wheel beams will be supported by 2-inch rods with 2½-inch upset ends, hung from posts made of 6 in. × 8 lb. latticed channel bars, with tie rods 1¾ in. diameter and 2-inch turn-buckles running from post to post close under boiler deck.

65. Guard chains.—The guards will be held at intervals by chains of similar design to the above, but rods will be 1½ in. diameter with 1½-in. threads, and the posts will be made of two 4-inch channel bars riveted together through web, the tie rods being 1½ inch diameter with 1⅝-inch turn-buckles.

66. Guard rim and nosing.—Along the outside of guard and attached to all the outriggers will be a plate 8 inches deep by 10.2 lb., the top and bottom edges stiffened by 3 in. × 3 in. × 6.1 lb. angles, the upper one riveted to deck of guard and the lower one to under plate sheer, which will be 12 inches wide by 10.2 lb. The nosing will be of white oak 6 in. × 8 in., rebated to fit angles and secured to plate with ¾-inch bolts placed 18 inches apart and staggered. Alongside of paddle boxes and extending aft to about frame No. 100 the nosing to be backed with a 3-inch filler, making a total thickness of 9 inches, as shown on sheets 3 and 7. Joints are to be scarfed 3 feet long, and everywhere where the oak comes in contact with metal a thickness of tarred felt must be inserted. All edges of nosing are to be properly rounded and finished in a neat and workmanlike manner, and the corners at bow and stern protected by bands of 6 in. × ½ in. iron properly chamfered at the edges.

67. Transom.—This will be of 12.75-lb. plate, 24 inches deep, with stiffening plates for rudder bearings.

68. Stanchions and stringers.—Stringers of 3 in. × 2½ in. × 5.5 lb. angles are to run from bulkhead No. 32 to collision bulkhead No. 10 and have stanchions of 3 in. × 3 in. × 6.1 lb. angles riveted in with small gussets at 36 inches apart. Any other stanchions that may be needed under boilers or under any machinery not sufficiently carried by bulkheads or truss frames must be supplied and riveted to deck beams and floors in an efficient manner.

69. Additional trusses.—The heavy pumping machinery will require additional truss framing between deck and floor, which must be put in, also any other trussing that may be needed for any of the other heavy machinery.

70. Foundations for boilers.—The requisite beams under the ash pans and cradles for mud drums will be provided and riveted to deck.

71. Foundations for machinery.—That part of deck upon which the main engines and pump are placed will be reenforced with 15.3-lb. plate, the spaces between the deck strakes being filled both inside and outside with plates fitted snugly between the edges of laps, thus making a total thickness of ⅛ inch. Under the air and jet

pumps filling plates are to be inserted where required, and all filling or doubling plates required for other purposes are to be provided.

72. *Discharge pipes in hold.*—These pipes will be 32 inches diameter inside and made of 10.2-lb. plate, with flanges of 2½ in. × 2½ in. × 5.9 lb. angle bar riveted through and through with bulkheads and forming a part of the hull structure. Care must be taken to have the longitudinal seams placed on top of pipe with as short a crossing of joints as possible and the circular seams laid in the direction of the flow. At all flanges throughout the main pump pipes the plate forming the pipe must come flush with flanges in order to prevent the sand from cutting the plate and care must be taken in cutting holes in the bulkheads that when finished all the plates shall be quite flush with each other, as shown by section on sheet 6. The discharge pipe where it passes through the rake of stern must be made of 15.3-lb. plate for about 18 feet of its length, and must be connected to hull with flanged plates not less than ¾ inch thick. All rivets in discharge pipes must be countersunk and driven flush on the inside. The bend of pipe from bulkhead No. 46 must be made of plate ¾ inch thick in small segments. At the after end of pipe a hand-hole must be provided, fitted with a cover which can be quickly removed, for the purpose of filling or emptying the pipe by means of a siphon.

73. *Bow girder.*—A box girder will be built between the two wings at fore end of well, flush with nose of dredge, this girder to be 36 inches wide and 36 inches deep, the top standing 12 inches above deck, and is to be made of 10.2-lb. plate, with 3 in. × 3 in. × 7.2 lb. angles on three corners and 7 in. × 3½ in. × 19 lb. angle on the forward bottom corner; the girder will be strengthened by six transverse ties, spaced equally, and made of $\frac{5}{16}$-inch gusset plates and 2½ in. × 2½ in. × 5 lb. angles. A second 7 in. × 3½ in. × 19 lb. angle bar will be riveted 18 inches above bottom, and both will be perforated with holes for screen bars at a distance of 8 inches, center to center. The screen bars will be made of 3-inch extra heavy pipe 4 feet long, held in place by ¾-inch pins at top end. On the upper edge of girder a nosing of white oak 8 in. × 10 in. is secured, rebated, and bolted similarly to the side nosing. This girder is shown in detail on sheet 6.

74. *Stack knees.*—Four stack knees are to be built on the bow girder, as shown on sheet 6. The front plates and knees are to be of 12.75-lb. plate and the angles 3 in. × 3 in. × 7.2 lb. The posts are to be of white oak, 9 in. × 9 in., mortised into nosing and bolted to knees; the fenders to be 7 in. × 11 in. at bottom and 5 in. × 11 in. at top, and must be made of best white oak or hickory, fitted with eyebolts and properly lashed.

75. *Cylinder beams.*—These beams are to be built according to sheet 8, except in so far as they may require modification to meet the requirements of the particular engines accepted for the dredge. The webs are to be of 12.75-lb. plate, the top chords to be two 4 in. × 4 in. × 15.7 lb. angles, with a cover plate 9 inches wide × 25.5 lb., the bottom chords to be two 3 in. × 3 in. × 7.2 lb. angles riveted to deck. Stiffeners of 2½ in. × 2½ in. × 5 lb. angles will be placed about 36 inches apart, and gussets and tie plates as required.

76. *Hoisting frame.*—This frame, from which the suction heads are to be suspended, will consist of two A frames set upon each side of well and joined together at the head by a girder. The legs are to be of 12 in. × 20.5 lb. channels, tied together by diagonal bracing and secured to deck and girder by gussets and angle clips. The top girder to be made of two 15 in. × 33 lb. channels with top and bottom plates ¾ in. thick, forming a box girder 15 inches wide. The tackle blocks will be suspended from U bolts, passing through steel castings, which carry rope sheaves for handling the clamping bars, all as shown on sheet 13.

77. *Spud well.*—This is built near bow of dredge, between frames 24 and 26. It will be 23½ inches square in the clear on the inside, made of 12.75 lb. plates and 3 in. × 3 in. × 7.2 lb. angles. The bottom flange must be a steel casting, double riveted to hull plating. See sheet 16.

78. *Bitts, chocks, and cavels.*—The following number of these deck fittings are required, placed where shown on deck plan, sheet 3. They must all be set on stiffening plates riveted independently to deck plate and beams, and must be secured by riveting as far as possible: Four large cast-iron mooring bitts about 11 inches diameter and 24 inches high; twelve smaller bitts about 7 inches diameter and 16 inches high; six double sheave chocks with sheaves about 9 in. × 3 in.; two single sheave chocks; four cavels about 4 feet and four 2 ft. 6 in.; and such ring bolts as may be required for snatch blocks.

79. *Fair leads.* Two pairs of fair leads with 24-inch sheaves for 1-inch diameter wire rope are to be made as shown on sheet 6 and set in place on bow girder as on sheet 2.

80. *Hatches.*—Hatchways must be made in deck to give access to the several compartments of the hold, and be provided with iron covers made of 5.1 lb. plate with

1½-inch angle rings and stiffeners on the underside and ring bolts for lifting. Iron ladders must be provided and placed in convenient position in each hatchway.

81. Rudder knees.—Two box knees, 4 feet high, made as shown in detail on sheet 6, are to be built at stern.

82. Rudders.—Two balanced rudders are required, each placed at a distance of 9 feet from the center line of boat. The rudder stocks are to be lap-welded pipes 8 inches diameter and ⅝ inch thick and about 18 feet long, and will have three grooves turned in each at the distances required to receive the pintle bands. These bands are to be good sound forgings and must be bored to fit the grooves snugly, sprung into place and securely bolted. Near the upper end of stock, cheek pieces, either forgings or steel castings, must be riveted and have a 2½-inch pin hole bored through center to receive the tiller pin. At the end of stock a smaller hole is required for the tiller brace. The blades of rudder are to extend forward 12 feet, shaped to fit the rake of hull, and on the after end the blade is to be 12 feet long and 4½ feet wide. The blades are to be built of 7.65 lb. steel plates and 2½ in. × 2½ in. × 5 lb. angle bars. Pieces of 7.65 lb. plate will be bent to fit the stock and will be flanged on both sides and riveted to both the fore and after faces of stocks. Secondary stiffening plates will be riveted on the athwartship center line of stocks, and will fit close to and extend beyond the above flanged plates, both fore and aft. The plates of blades will be laid on these stiffeners and will be riveted thereto, then brought together at the fore and aft edges and riveted together with a 3 in. × ½ in. bar inserted between. The side plates will be stayed throughout by ½-inch through rivets, with pipe ferrules inserted between. The bottom will be closed with a $\frac{3}{16}$-inch plate and outside angle bar 2½ in. × 2½ in. × 5 lb.; and finally, the top edge will be filled in with hard wood about 3 inches thick and riveted through and through. The rudders are not to be water-tight, and a number of 1-inch holes will be punched in bottom plates. The pintle pin will be 1¾ inches diameter, and bronze washers will be inserted between all the lugs in order to insure a distribution of the weight of rudders on each bearing. Lifting shackles and bumpers will be provided.

83. Tillers.—Each tiller will be made of two (2) 4 in. × 1 in. bars riveted together with separators between, as shown on sheet 6, and will have eyes forged at one end to couple to rudder stocks, and a ring at the forward end for attaching tiller ropes. The two tillers will be connected by a brace of 3-inch tube with pin joints at each end, and the weight of outer end will be sustained by a brace of 1-inch iron, with upset thread, running to head of rudder stock. Any modification of the tiller ends that may be necessary to accommodate the steam steering rig will be made as required.

84. Sheer legs.—A pair of sheer legs will be set up at stern for lifting the swivel elbow and rubber hose connection. These are to be made of tubing with stub ends welded in, and will be stepped by pin joints in steel castings riveted to deck. Extra lugs are to be placed for setting up legs over rudder, and ring bolts or other fastenings to be provided for securing back guys and snatch blocks.

85. Material and workmanship.—The best quality of material and workmanship will be required in each and every part of the work done under these specifications. All plates and angles used is said work are to be of soft steel having an ultimate tensile strength of from 52,000 to 62,000 lb. per square inch, the elastic limit not less than one-half the ultimate strength, with an elongation of 26 per centum in 8 inches and a minimum reduction of area at fracture of 50 per centum. One test piece for tensile strength and one for bending shall be taken from the steel of each heat. For the bending test, the pieces must bend cold 180 degrees flat upon themselves without fracture on the outside of bent portion. A variation of more than 2½ per centum above or below the specified weights will be cause for the rejection of any material. Rivets will be tested cold by driving the shank into the head; the rivet must then be without sign of fracture on the outside edge. Facilities must be given to the inspector by the manufacturer and contractor for making these tests, the cost of which will be borne by the contractor.

86. Testing of hull—The bottom of hull will be tested for water-tightness by filling with water to a depth of about 6 inches, before the boat is launched, and all leaks and imperfections then discovered will be made good.

UPPER WORKS.

87. Deck house.—The forward end of deck house will be on frame No. 32 and the house will extend aft to frame No. 117; it will be 44 feet wide throughout and 12½ feet high at sides.

88. Material.—All lumber used in the construction of the upper works and in all other carpenter work must be first class, clear and well seasoned, free from sap wood and shakes, dressed on sides and edges, and of the sizes specified after being dressed.

89. *Framing.*—The main stanchions are to be of white oak 3¾ in. × 3¾ in., placed about 8 feet apart and secured by angle clips bolted to deck, as shown in detail on sheet 6. The intermediate stanchions are to be of 1⅞ in. × 2¾ in. white pine, spaced about 24 inches apart and checked into the coaming, which is to be of white oak 4¾ in. × 5¾ in., securely bolted to deck, with a layer of tarred felt interposed.

90. *Clamps.*—The outside clamps are to be 1⅝ in. × 10 in. white pine, and the inside clamps 1⅝ in. × 6 in. white oak, checked into stanchions and bolted with ½-inch carriage bolts.

91. *Carlins.*—These are to be 1⅝ in. × 6 in. yellow pine, spaced about 18 inches apart, centers curved to a crown of 6 inches and checked over inside clamp 1 inch deep. Each carlin will be in two pieces, overlapped or scarfed in center and projecting 6 inches beyond outside clamp. The carlins are to be doubled at bulkheads or where extra strength is required.

92. *Stringers.*—These are to be of yellow pine 3¾ in. × 5¾ in., in long lengths, with scarfs 3 feet long, bolted and nailed and secured to caps of stanchions by ½-inch screw bolts.

93. *Stanchions and trusses.*—All stanchions for stringers are to be made of 3½-inch diameter iron pipe, secured to deck and stringers by cast-iron flanges, and distributed as shown on sheet 3. Where the span between the stanchions is over 10 feet the boiler deck is to be supported by trusses.

94. *Boiler deck.*—This will be laid with white pine ⅛-inch thick in strakes 3 inches wide, tongued and grooved, and beaded on underside. The height of boiler deck from main deck will be 12½ feet. The guards will overhang the deck house 6 inches and will be finished with a waterway 3½ in. × 1¾ in., facing 8 in. × ⅞ in., nosing 6 in. × ⅞ in., all of white pine. The boiler deck is to be doubled over the whole of intermediate section of cabin between the two passages, with white pine ⅛ in. thick, in strakes 3 inches wide, slightly outgaged, calked with cotton and payed with thick white lead.

95. *Siding.*—The deck house will be sided with white pine ⅛ inch thick, tongued and grooved, and beaded on both sides, in strakes 3 inches wide, laid longitudinally except at round corners, which will be vertical. A row of transom sash will be placed below clamps, and all doors, windows, and shutters will be put in as required.

96. *Bunker.*—This will be built of the size and in the position shown on sheet 3. It will be made substantially in the same manner as the side bulkheads, sided on the outside of studding clear up to carlins and on the inside to a height of 6 feet with 1½-inch yellow pine, tongued and grooved.

97. *Stairs.*—There will be two flights of stairs on each side of boat from guards to boiler deck. They will be 30 inches wide, with oak treads 9 in. × 1⅛ in., with about 7½-inch rise. Two sets of steps from boiler deck guards to top of paddle boxes, two sets from paddle boxes to hurricane deck, and six sets to skylight roof, are to be provided.

98. *Lockers.*—Such lockers as are usual and requisite for engine room and ship stores, lamp room, and mate's lockers are to be provided, as shown.

99. *Lavatory, etc.*—Three closets located abaft the paddle box on port side and a crew's wash room in a similar position on starboard side are to be provided and fitted out as hereafter described.

100. *Paddle boxes.*—These are to be made, as shown on sheet 9, with a framing of 2½ in. × 2½ in. × 5 lb. angle bars, upon which nailing strips of poplar 2½ in. × 1½ in. are to be bolted with ½-inch carriage bolts. Coamings of white oak 4¾ in. × 3¾ in. are to be bolted to bridge trees with a strip of tarred felt interposed, upon which the stanchions are stepped. These are to be of white pine or poplar 2¾ in. × 1⅝ in., spaced 18 inches apart centers and secured at top end to angle framing. The whole is to be sided with white pine ⅛ in. thick, in strakes 3 inches wide, tongued and grooved, and beaded on outside. The outboard face is to be neatly finished with facing of white pine 6 in. × 1⅛ in., panel of poplar 12 in. × $\frac{5}{16}$ in. thick, and a 2-in. half-round molding rebated over panel. The center piece of lattice work is to be removable and the star is to be made of $\frac{5}{16}$-in. panel and 1½-in. half-round molding. The bulkhead of deck house will form the inboard siding, but it will be doubled by ⅛-in. white-pine siding tongued and grooved, with vertical nailing strips 1¼ in. × 1¼ in. between. Both bulkhead and doubling must be painted with three coats of pure white-lead paint before being closed in. A flight of steps 24 inches wide is to be placed on each side of paddle boxes.

CABINS.

101. *General.*—The general arrangement of cabins is shown on sheet 4. The total length will be 137 feet and the width 34 feet. The forward cabin will contain 13 staterooms, bathroom, and storeroom, all 10 feet wide, with office and messroom 14

feet wide between. The intermediate section will contain kitchen, pantry, three storerooms, laundry, laundress' room, wash and bathrooms, and closets for officers. The after section will contain quarters for cook and waiters, ice box and storeroom open to passage, crew's messroom, crew's quarters, and two bathrooms. There will be two passages 5 feet wide between the sections. The skylight will extend full length of cabin at a width of 14 feet.

102. Dimensions and material.—The cabin outside stanchions are to be of poplar, 1 in. × 3½ in.; the inside stanchions of poplar 1½ in. × 3 in.; the plank-sheer of white pine, ⅞ in. × 3½ in.; the outside clamps of white pine, 1½ in. × 7 in.; the inside clamps 1½ in. × 5 in.; the carlins of poplar, 1 in. × 4 in., the bulkhead strips of poplar, 1 in. × 1½ in.; the panels of poplar, $\frac{5}{16}$ in.; the margins of white pine, ⅝ in.; the roof facing and nosing of white pine, ¼ in. × 4 in.; the waterway of white pine, ¼ in. × 2 in. The skylight clamp is to be of white pine, 1½ in. × 8 in.; carlins of poplar, 1¼ in. × 5 in.; facing of white pine, ¾ in. × 4 in.; nosing of white pine, ½ in. × 3 in.; waterway of white pine, ¾ in. × 1½ in.

103. Construction.—The cabin and skylight roofs are to be ½-inch white pine, tongued and grooved, beaded on under side, and double nailed to each carlin. The height of cabin from carlin to carlin will be 8 feet, and the general construction will follow the ordinary river practice. The cabin ceiling will be paneled with an ogee molding; the skylight carlins will be capped on the under side; a plain cornice will extend the full length of the skylight, and the forward cabin will be finished with pilasters on each side of doors and plain brackets to cornice. All rooms will have transom sash on the outside, and those in forward cabin will have transoms inside also. The intention is to have all the joiner work done in a thoroughly good and substantial manner and neatly but plainly finished. The cabin will have four (4) ⅝-inch bolts on each side, passing from carlins to under side of boiler deck carlins.

104. Pilot house.—This will be 13 feet long fore and aft, 13 feet wide, and 10 feet high from skylight roof to under side of carlins. The floor beams will be 1½ in. × 10 in., spaced about 18 inches centers, carried on rails 1¾ in. × 6 in., on each side of house. The floor is to be of ½-inch yellow pine, tongued and grooved. The corner stanchions will be 3 in. × 3 in., and the siding is to be of white pine ⅝ in. thick, tongued and grooved, and beaded on both sides. The pilot house will be fitted with the usual adjustable sight shades in front and with sliding sashes on the other three sides. The sashes will be 1⅝ inches thick, and mounted with rollers on brass water tables. A door 30 inches wide will be provided in after side of pilot house, with suitable steps to same. The pilot house will be securely fastened down by a ⅝-inch bolt at each corner stanchion.

105. Pilot wheel.—This will be 10 feet in diameter over all, with double rim of usual construction and mounted in the usual manner. The barrel will be 15 inches in diameter, and the necessary tiller ropes, ½ inch in diameter, with all sheaves and sheave boxes, will be provided and fitted in place in a first-class manner. The fittings in pilot house will include speaking tube to engine room, bell tube, bell stand, all necessary bell pulls and bell cranks, and wiring to engine room and whistle; also a settee with drawers underneath.

106. Roofs.—All roofs will be covered with 12-oz. cotton duck, U. S. Army standard, of approved make, well lapped at edges and secured with 10-oz. tinned tacks, laid on a thickness of heavy roofing felt and painted with two (2) coats of pure white lead, ground in boiled linseed oil and toned to lead color with lampblack. The boiler-deck guards for the full length of cabin and the passageways must also be covered with canvas and painted same as the roof.

107. Guard rail.—This will extend all around the boiler deck. It will be made with stanchions of white oak, 1¾ in. × 1¾ in., spaced about 6 feet apart centers, with one short stanchion of white pine between. The rail will be 29 inches high. The caps are to be of white pine ⅞ in. × 4 in., with filling on each side of stanchions ⅝ in. × 2 in., and two rails of white pine ⅝ in. × 2 in.

108. Doors.—All doors will be made of white pine; those 27 inches wide and under to be 1 inch thick and those above 27 inches wide to be 1¼ inches thick. Inside doors will be paneled and outside doors will have the lower part paneled and the upper part glazed. All stateroom outside doors will be fitted with blinds of white pine ¼ inch thick. The doors will be hung with steel loose pin butt hinges and fitted with rim locks and white porcelain knobs of extra good quality, and all necessary brass hooks and eyes of ship-cabin pattern. The blinds to outside doors will have 2½-inch brass shutter bars with brass hooks and eyes for fastening back. The sliding doors on main deck will be mounted with "run-easy" warehouse hangers with 6-inch wheels and 1¾ in. × $\frac{5}{16}$ in. rails, and will be fitted with flush door handles and suitable locks.

109. Windows and transoms.—The windows will be single sash 1¼ inches thick and transom and skylight sash will be 1 inch thick. The windows will be made to

drop on inside of bulkheads and will be fitted with slides and water tables, sash weights, pulleys, cords, and fastenings. The transom sash will be hung at top, the skylight sash at bottom, and all will be provided with the necessary buttons, chains, hooks, and spring bolts. All glass used is to be of double strength "American," and sashes must in all cases be made to use lights of standard size. All hardware furnishings must be approved by the engineer officer in charge.

110. Forward cabin and staterooms.—Each of the eight staterooms in after part of cabin will be fitted with a locker 36 inches wide and 21 inches deep, with two (2) drawers below and paneled doors in two parts above, and provided with drawer pulls, cabinet locks, hinges, spring catches, and six (6) heavy clothes hooks to each locker. The floors of office, officers' mess, and all staterooms in forward cabin, also floor of pilot house, will be covered with linoleum. Iron bedsteads will be furnished throughout the boat, as hereafter specified.

111. Kitchen, pantry, etc.—The kitchen will be fitted with fixed tables, placed as shown on plan, and the pantry will have a wash table, four (4) tiers of shelves, and drawers. Storerooms will also be fitted with shelving in a complete manner, a baker's table as shown, and the doors will be fitted with first-class locks.

112. Laundry.—The laundry will be furnished with an ironing table 24 in. × 36 in. on top, made of white pine, and the laundress' room will have linen lockers, with shelves and double doors.

113. Crew's mess room.—This will be furnished with two plain tables 3 ft. × 11 ft., made with pine frames and hard-wood tops; also four seats 11 feet long to suit same.

114. Ice box.—An ice box of first-class construction, charcoal filled, will be placed in after passage and fitted with drain pipes.

DREDGING MACHINERY.

115. Main pump.—This is to be a 32-inch centrifugal double-suction pump, with discharge at bottom, and made in accordance with sheet 10. The pump runner is to be of steel, with five (5) blades 84 inches diameter, to each side of which will be riveted a steel plate ring ⅜-inch thick. The flanges on blades must be machined and after the plates are riveted on the outside they must be turned to a true surface. The pump runner to be secured with two keys driven from opposite sides, and the keys prevented from backing by fillers fitted between key and end of keyseat which in turn will be held in place by the false hubs shown on sheet 10. The pump casing will be divided horizontally through the axis of shaft, and the top half will be divided again vertically, and all will be put together with planed joints. The casing to be of the thickness indicated on sheet 10 and to be fitted with liners throughout. The casing to be machined on the inside as far as the periphery of the runner, and this part to be lined with steel plate ⅜ inch thick. As the clearance between pump runner and liners must not exceed $\frac{1}{16}$ inch, special care must be taken to have the plates properly straightened and free from inequalities. Beyond these center liners the side liners will be of cast iron 1 inch thick, divided as shown, and the shell liners will be of steel plate ⅜ inch thick. All joints of liners to be fitted as closely as possible and to be machined where necessary. All patterns used for making liners to become the property of the Government. The suction elbows are to be 24½ inches diameter, increasing toward the casing to 34 inches, and must be made in halves and set at an angle of 45 degrees as shown; provided with stuffing boxes lined with brass sleeves, and fitted with brass glands and sand-intercepting chambers to which water-jet connection will be made. All fittings which go on shaft must be in halves, with faced joints, and must be put together in a first-class manner. A flange, well bracketed, must run all around lower half of casing for securing pump to deck, and lugs or eyebolts and shackles must be provided for lifting the various parts. The pump is to be provided with a 4-inch air exhauster with pipes arranged as shown on sheet 2, having flange connections for easy removal. The suction elbows will have hand-holes for examining the inside of pump, and the junction pipe on discharge will have a full-size manhole, the covers in all cases to be as close a fit as possible and flush on the inside.

116. Pump shaft.—This is to be forged of best hammered scrap or mild steel 9½ inches diameter in center, tapered to 8½ inches at stuffing boxes, and about 12 feet long. A flange coupling of cast steel will be keyed on each end.

117. Main engines.—These are to be horizontal tandem compound condensing, with properly proportioned cylinders and 24-inch stroke. They must be designed for heavy and continuous service and should not exceed the space allotted to them on the plan. The crank shafts are to have flange couplings on one end worked solid with the shaft to match those on pump shaft. The cylinders are to be provided with automatic drain cocks, relief valves, sight feed, and other lubricators, and a separator for each engine, also indicator cocks on each cylinder, and rig for taking diagrams.

The holding down of engines will be by continuous flange all around base and frequent bolts of small size. The engines will be run continuously at a working speed of 140 revolutions per minute, but must be perfectly balanced for running a test speed of 155 revolutions per minute.

118. Throttle valve, etc.—A balanced regulator or throttle valve is to be provided, with a convenient arrangement of handle for working same placed between the engines. The steam pipes are to lead by easy curves from each side of valve to the separators, which are to be directly connected to the cylinders, and the drain from separators must be taken off by a steam trap of a make to be approved by the engineer officer in charge.

119. Condenser and air pump.—The condenser is to be of the independent type, of Worthington or Blake make, and the air pump is to be duplex compound, with steam cylinders 10 and 17 inches diameter, water cylinders 19 inches diameter and 15 inches stroke, or a cross compound of equivalent power. The water cylinders are to be brass lined and the pistons fitted with suitable packing. The pump will discharge into a hot well placed in the hold of dredge and fitted with a steam-tight cover, and the injection will be taken from a tank fitted with brass-wire screen and shut-off valve on inlet.

120. Jet pump.—This pump for supplying the water to nozzles of jet agitator is to be a Worthington or Blake horizontal duplex compound, with outside packed plungers. The steam cylinders are to be 10 and 20 inches diameter, and the plungers 16 inches diameter by 15 inches stroke. The steam pipes are to be arranged so that live steam can be used in low-pressure cylinder, and all parts must be made of sufficient strength for this purpose. This pump will be required to work against varying pressures, from about 60 lb. when working compound, to 120 lb. when working the large cylinder high pressure. A modification of the ratios of cylinders will be allowed, if desired. The pump plungers must be made as light as consistent with the required strength and must be of hard, close-grained iron, and the glands and stuffing boxes must be bushed with bronze. The valves must have ample area and the passages be large and direct. The cylinders are to be made of hard, close-grained iron of sufficient thickness to admit of reboring, and the pistons will be fitted with approved adjustable packing rings. The cylinder heads must be so arranged that the pistons can be removed without taking down any other part of machinery. The suction will be taken from a tank placed in hold of dredge, which must be fitted with brass-wire screens and the inlets provided with shut-off valves as close to hull plating as practicable.

121. Suction heads.—These are to be made as shown on sheet 11. Each mouthpiece is to be 11 feet 6 inches wide and 8½ inches deep at its smallest part and have a flared entrance, the upper edge being strengthened by a 3 in. × 3 in. × 7.2 lb. angle bar and the lower edge by a 4 in. × 13.8 lb. Z bar or double angle riveted together. The heads will gradually contract until they are 22 inches square inside, at which size they are continued to the bow and enter the hull by means of radial joints. The heads are to be built of steel plates 12.75 lb. on top and sides and 15.3 lb. on bottom, with 3 in. × 3 in. × 7.2 lb. angle bars in corners. All joints are to be closely butted with straps outside, and all rivets to be countersunk on the inside and made flush. A double angle bar 4 in. × 3 in. × 8.5 lb. is to be riveted on each side of center line on top side, with a plate between to which the sling chains are to be connected by shackles. The entrance of mouthpieces will be fitted with screen bars of cast steel, placed at 8 inches centers, held in place by a bar of 1¼-inch pipe secured at each end. Stiffening bars of 2½ in. × 2½ in. × 5 lb. angles are to be riveted to upper lip of mouthpieces.

122. Radial joints.—These are to be made as shown on sheet 12. Both hinge pieces are to be steel castings, all flanges to be faced and pin holes bored an easy fit for 3½-inch pins. The pipe pieces are to be riveted to suction pipes, and the plates and angles to come flush with face. The radial pipe is to be of cast iron and to be machined all over to a smooth surface. The inside pipes are to be of cast iron, faced on flange and bolted independently to the bow hinge pieces. These pieces will change from square to round and be connected to the suction pipes of pump by short pieces of 8-ply rubber hose made of best Para rubber, with the inside lining of pure rubber ¼-inch thick, the ends also being capped with rubber to entirely protect the canvas from exposure.

123. Water jets and pipes.—A header of 8-inch standard pipe will be placed behind Z bars on under side of suction head, perforated with 12 holes tapped for 2-inch pipe, into which bronze nozzles with 1-inch outlets are to be screwed, the ends of nozzles to rest in holes made in center of Z bars. The 8-inch pipes will be continued from a tee in center of header along the under side of suction heads to near the upper end, where connection will be made to branch on hull by sections of smooth-bore suction

hose, which must be of sufficient strength to stand a pressure of at least 180 lb. per square inch.

124. Hoisting tackle.—The suction heads will be suspended from the frame at bow of dredge and will be hoisted separately by manila-rope tackle blocks, from gipsy head on hauling winch.

125. Hauling-ahead winches.—Two winches are required, which must be fitted up for right and left hand and made substantially as shown on sheet 15. The engines are to have 7 in. × 7 in. cylinders, geared about 412 to 1. The drums are to be 48 inches diameter, grooved for 1-inch wire rope and fitted with all clutches, brakes, levers, etc., required for operating. All the pinions are to be of steel and the worms of bronze. The winches are to be neatly finished in all parts, the cylinders lagged with planished steel, 16 B. W. G., the bottom flanges to be planed and ample holding-down bolts provided. Gears which run loose to be bushed with bronze. Gipsy heads to be fitted on outer ends of worm-gear shaft.

126. Spud anchor and lifting gear.—The spud anchor is to be of best white oak, 22 inches square and 36 feet long over all, fitted with a cast-iron shoe at lower end. The lifting cylinder is to be 18 inches diameter, with a stroke of 6 feet, and fitted with a steel piston rod 4 inches diameter; the piston to have approved packing rings; the gripping cam to be of steel; the links of forged steel or iron, and the racks of steel; the tripping dog is to be forged of steel or iron and fitted up in the best manner; a back roller is to be provided with bearings for same, and also a 2-inch rotary valve, and all working handles.

127. Capstans.—Three double-barreled steam-power capstans are required, two for forward deck and one for stern. The engines are to have cylinders 7 in. × 8 in. All the gears are to be of steel and the worms of bronze. The engines will be placed in hold, the forward ones on foundation plates riveted to floor beams and the after ones on under side of deck. They are to be "Providence" or "Hyde" capstans, or others of equal quality approved by the engineer officer in charge.

128. Steam steering rig.—This is to be of a design approved by the engineer officer in charge, and must be as simple as possible, easily handled, must not interfere with the use of the pivot wheel, must be quickly disconnected, and must be first-class in every respect.

129. Bilge siphons.—Two 2½-inch bilge siphons to be placed in each water-tight compartment, fitted with all necessary valves, piping, and suction screens. As the lift of the water is only about 5½ feet, the size of steam pipes is to be made in proportion. The height of discharge above water is to be not less than 18 inches, and those siphons discharging aft of wheels are to have elbows on outside to prevent wash of wheels being taken inboard. A 2½-inch siphon is to be located at the stern of the boat and connected with two pieces of smooth-bore hose, so that discharge main can be filled or pumped out, as required.

130. Pipes through hull.—All pipes discharging through hull are to be connected by tight joints to skin plate; all above 1½ inches by flanges and bolts, and the smaller pipes below 1½ inches by lock nuts. Steam traps must be supplied where required to prevent steam from being blown about the boat, and all pipes discharging under pressure are to have elbows on the outside.

131. Main discharge pipe.—The main discharge pipe will occupy one of the two positions in the hull shown on the drawing. The position to be chosen will be determined by the engineer officer in charge after the selection of the form of floating support for the pipe line. The necessary instructions will be given the contractor in due time. If the swivel connection is required, it will consist of two elbows 32 inches inside diameter, coupled together by collar flange working in a recess and held in place by a ring and bolts. The elbows are to be steel castings and the flanges and ring to be truly turned and bored to a working fit and have a bronze friction ring inserted between the faces. The lower elbow is to be riveted to the end of discharge pipe projecting through stern of dredge, and the upper elbow to have a bead on outer end on which the rubber-hose connection is to be clamped. Both upper and lower parts are to be braced with rods fitting into jaw brackets of steel, riveted to hull, as shown on sheet 14. The gudgeon for pivot brace is to be turned, and the eye of brace to be bushed with bronze. The side gudgeons for coupling bars are also to be turned. Two forged eyebars backed with 5-inch T-bars are to be supplied for coupling the pipe line to dredge.

132. Pipe line.—The pipe line and its appurtenances will be constructed under a separate contract. Should this contract be let to another party, the contractor for the dredge must at all times give the builder of the pipe line every facility for taking measurements or obtaining other necessary information to enable him to properly perform his work.

133. Hydraulic piles.—The dredge is to be supplied with twenty piles 11 inches outside diameter and 35 feet long, made in two sections; the lower 20 feet long, of tube

¼ inch thick, and the upper 15 feet long, of tube ⅜ inch thick, joined together by cast-steel flanges shrunk or pressed on and riveted. The flanges must be bored accurately to gage and truly faced, so that joint can be made without a gasket. The cap is to be a steel casting and made water-tight, and the upper tube is to have a hole drilled and threaded for 2½-inch pipe.

134. Ropes.—Two hauling cables to be supplied, each 1,200 feet in length, of one-inch diameter steel hoisting rope, 19 wires to the strand and of "Hercules" brand or other of equal quality. Also one full coil of best manila rope of the size required for tackle blocks for hoisting suction heads.

135. Electric-light plant.—This installation is to consist of a direct-coupled vertical engine and generator of the multipolar type, of 110 volts and the necessary capacity for operating the number of lamps specified below with a margin of 20 per centum overload without undue heating. A slate switchboard is to be placed in a convenient position in engine room mounted with ammeter, voltmeter, rheostat, pilot lights, and main switches for three circuits, one for main deck, one for cabin deck, and one for arc and search lights. Two search lights, each of 4,000 c. p., with 18-inch reflectors, are to be provided, arranged with both revolving and deflecting movements, the forward one to be operated from both the pilot house and the operator's platform, and the other from main deck. Two arc lights of 1,200 c. p. each are to be placed at each end of boat, arranged to give light to forward and after decks and to the main guards. These lights will be carried by spars, which must be properly rigged with guys and tackle for raising and lowering lights. The cabin deck will be lighted with 59 incandescent lights, distributed as follows: One combination electrolier for three lights and 3 coal-oil lamps in office; three combination electroliers for two lights and 2 coal-oil lamps, two in officers' mess and one in kitchen; three portable lights for desk use in office and mess room; twenty-three bracket lights in state-rooms, bathrooms, and closets; eight short pendent lights on guards, and sixteen hanging lights for storerooms, crew's mess room, crew's quarters, etc. The main deck will be lighted by about 36 lights distributed as shown on plan; these will be principally hung from wires and some will be portable and have wire guards. The hold is to be served with four lights, with long wires and wire guards to lights. All sockets are to be of the Edison pattern, and such as can be easily reached from the deck are to be key sockets, and all others are to have switches at convenient places for use. The lamps in cabins are to have suitable shades and all fixtures are to be very plain, but stronger than the ordinary commercial ones and put up in a thoroughly substantial manner. Two 32 c. p. lamps are to be furnished for chimney signal lights, with proper colored globes and suitably mounted in place, the switch to be located as required. All wiring in cabins and staterooms is to be concealed in neat mouldings, which are to receive one coat of white lead paint before being put in. All wires passing through bulkheads are to be enclosed in porcelain tubing; all insulators are to be of porcelain and the wiring and fittings generally to be in accordance with the rules and requirements of the National Board of Fire Underwriters.

PROPELLING MACHINERY.

136. Designs for engines.—Bidders are required to submit designs and specifications for propelling engines, subject to the conditions herein specified, as it is intended that contractors may use existing patterns if desired. Any slight modification of the cylinder beams that may be desired by the contractor will be allowed if it does not interefere with any of the other work on the boat.

137. Engines.—The engines are to be of the usual Mississippi River type, adapted for side wheels, and must be built of ample strength for working under a steam pressure of 170 lb. per square inch. Special attention must, however, be given to reducing weights as much as possible consistent with strength required. The engines must be of simple design and have large wearing surfaces, balanced valves, and variable cut-offs, both of types approved by the engineer officer in charge, and must have such modern improvements as are applicable to the design. They must be well fitted and neatly finished throughout, though a large amount of bright work will not be required.

138. Cylinders.—These will be of 22 inches diameter and 7 feet stroke, sufficiently thick to permit of two or three reborings, cast in dry sand molds, of hard, close-grained iron, very smoothly bored, counterbored ¼ inch at each end short of the travel of the piston packing rings, and must be entirely free from blowholes and spongy places. They must be first class in every respect, and will be fitted with the usual side pipes, valve boxes, valves, and gear, also automatic drain cocks, and will be covered with approved magnesia nonconductor and lagged with planished sheet steel about No. 14 gage. The cylinders will be fastened to beams without cast-iron bed plates, keying lugs only being used.

139. Piston rods.—These are to be of hammered steel. The piston heads and followers are to be steel castings, with cast-iron bull and packing rings. The rod will be fitted into piston against a shoulder, and into the crosshead butt against the end, with only sufficient taper to enable crosshead to be removed without driving. A backing cutter will be fitted to rod. Metallic packing of make approved by the engineer officer in charge will be used in stuffing boxes for piston rods.

140. Crossheads.—These are to be steel castings, and will be fitted with bronze gibs in the usual manner.

141. Slides.—These are to be fine, close grained, cast iron, truly finished, and will be fitted directly to cylinder beams without cast-iron bed plates.

142. Pitmans.—These will be about 26 feet long centers, and are to be built of steel lap-welded tube, with solid stub ends inserted and efficiently trussed, or of best quality white pine properly strapped, as may be decided by the engineer officer in charge. They will be fitted with brasses lined with best babbitt metal, and gibs and keys.

143. Shafts and cranks.—These are to be of hammered steel, well designed, and will be fitted up in accordance with modern practice. Three wheel flanges hooped with wrought-iron bands will be firmly keyed on each shaft.

144. Pillow blocks, etc.—The pillow blocks, yokes, cams and cam brackets, and all other details will be designed and fitted in accordance with best practice.

145. Throttle valves.—Each engine is to be fitted with a balanced throttle valve placed conveniently within reach of the engineer.

146. Operating gear.—Each engine will be handled from its own side of boat; all levers must be arranged to occupy as little of the available gangway as possible, the ship-up rig neatly and conveniently arranged, and the reversing shafts put under deck if necessary to make a suitable arrangement.

147. Bells.—Each engine must be supplied with signal bells of different and distinct tones, and all bells necessary for the proper working of the boat, together with fittings and wiring of first-class character, must be provided.

148. Paddle wheels.—The wheels will be 22 feet diameter over buckets, and each wheel will have three sets of arms, 15 arms to a set. The buckets will be 1¼ inches thick, 13 feet long, and different widths as required to balance the varying strains upon the crank. The arms will be 7 inches at flange, 12 inches at circle, by 3 inches thick; the circle segments to be 7 inches wide, set up with keys, and secured with iron rings on each side 5 inches wide and $\frac{5}{16}$ inch thick, bolted with four ⅝-inch bolts to each segment. Three sets of braces are to be fitted between flanges and circles. Battens are to be 7 inches wide and 1½ inches thick. Stirrups are to be made of ⅝-inch square iron with large square nuts, and washer plates are to be 6 in. × 3 in. × ¼ in. thick. All timber for wheels is to be seasoned white oak, except braces, which are to be of pine or poplar.

STEAM PLANT.

149. Main boilers.—There will be seven boilers of the usual Mississippi River type, of 44 inches mean diameter and 30 feet long, each boiler having four flues of 11 inches outside diameter. The boilers will be built in accordance with the rules of the Board of Supervising Inspectors of Steam Vessels, for a working pressure of 170 lbs. per square inch. The shells are to be of marine steel $\frac{30}{100}$ inch thick and 62,000 to 67,000 lbs. tensile strength. All holes will be drilled and longitudinal seams double riveted. The rings will be as long as practicable, and the longitudinal seams will be above the fire line. The flues are to be of lap-welded tube in 3 feet sections and $\frac{22}{100}$ inch thick, the joints carefully and tightly fitted into each other in a thoroughly first-class manner. The boiler heads must be annealed after flanging; the back heads will have full-sized manholes at top, and front heads will have large handholes at bottom. Manhole doors are to be "Eclipse" or other equally good. A certificate of inspection of the boilers must be filed with the engineer officer in charge before the Government tests begin.

150. Casing, breeching, and chimneys.—The boilers will be set in three separate batteries, and will have neat, substantial cast-iron fronts, fitted with fire, poker, and ash doors, grate bars, and bearers. The casings are to be made of sheet steel, No. 12 B. W. G., strengthened with angle-iron flange around top edge and at sides and bottom, and will be provided with all side stays and bottom stands necessary. The breechings are to be of good design, made of sheet steel, No. 8 B. W. G., and adequately supported and fitted with dampers to cut off each battery when not working. The chimneys will be 44 inches in diameter and 70 feet high above grate bars, and are to be made of sheet steel, the lower half No. 12 B. W. G., and the upper half No. 14 B. W. G., and will be strengthened with three angle bars 2½ in. × 2½ in. × 4 lb., running full length on the inside. The tops of chimneys will be finished with a 3-inch angle-bar ring, and all eyebolts, guy rods, turn-buckles, and fastenings will

be provided. The usual casings from boiler to hurricane deck are to be made of sheet steel No. 16 B. W. G., and will be fitted in place with proper deck rings and umbrellas in a thoroughly first-class manner.

151. Steam and mud drums.—Each battery will have a steam drum 30 inches in diameter and of requisite length, connected to each boiler by legs 10 inches in diameter and 6 inches long, double riveted to each. Manholes and doors similar to those on boilers will be put in heads. A main steam branch 6 inches in diameter will be riveted on each drum, and a dry pipe will be fitted on the inside. Steam branches for auxiliary lines and reenforcing plates will be put on as required. Two mud drums 16 inches in diameter for each battery will be connected to each boiler by legs 8 inches in diameter. A hand-hole will be put in each head, as large and as near the bottom as practicable.

152. Brickwork.—The boilers are to be built in, in a thoroughly first-class manner, with the best quality of fire brick in furnaces, bridges, and walls, and second-quality fire brick in fire bed and furnaces below grate bars. The covering tiles are to be of first-class quality, the ash pans to be lined with split brick, and throughout the whole of setting care must be taken to reduce the weight as far as possible consistent with good work.

153. Fittings and valves.—The boilers are to be furnished with all the usual and necessary fittings. Each boiler is to have one spring-loaded safety valve mounted on a flanged branch riveted to shell. There will be three try cocks in each wing boiler of each battery, and two in center boiler; feed and check valves for each battery; four 2-inch blow-off valves for forward and four for after mud drums, with internal perforated pipes and auxiliary gate valves in each overboard pipe; one 6-inch main steam valve for middle battery and two 5-inch for side batteries, and all auxiliary valves for other steam branches. All valves for steam and feed or that are subject to high pressure are to be "extra heavy" and adapted to the purpose for which they are to be used. All valves $2\frac{1}{2}$ inches and under are to be entirely of brass, unless otherwise sanctioned for special requirements by the engineer officer in charge, and in no case will the ordinary light commercial valve be accepted. It is advisable that uniformity in the make of valves be maintained as closely as possible, especially of those that have renewable valve discs. All connections 2 inches and upwards are to be made by flanged branches riveted to boilers. All fittings must be approved by the engineer officer in charge.

154. Steam pipes.—All steam and feed pipes above 2 inches diameter are to be of lap-welded tube, connected by flanges, and put on according to the rules of the Board of Supervising Inspectors of Steam Vessels. The main steam branches from steam drums will be 5 and 6 inches diameter, connecting by a cross on center line of boat and running thence 10 inches diameter to main engines, where it will be carried forward at reduced size to winches, etc. All bends in these pipes must be of large radius and very neatly bent. The auxiliary steam line will be 3 inches diameter and will be connected with auxiliary boiler, capstans, fire pump, siphons, electric light and shop engines. All pipes 2 inches and over to be connected by flange unions; all screwed unions throughout the boat must be of brass and of first-class make; and all screwed fittings must be of malleable iron.

155. Exhaust pipes.—The exhaust from the main engines and jet pumps will be connected with condenser and furnished with an efficient oil separator; and the exhaust from propelling engines, air pump, steam winches, electric-light and shop engines will be connected with heater. The large pipes are to be made of sheet steel No. 14 B. W. G., with end or flanged sections made of copper $\frac{1}{8}$ inch thick, in the manner of the best river practice. The exhaust from heater must be provided with the ordinary water catcher, outlet to atmosphere, valve for same, and blast nozzles of copper for chimneys. The exhaust pipes from winches, air pump, electric-light and shop engines are to be fitted with straightway shut-off valves. The capstans are to exhaust through sides of hull. All pipes must be efficiently drained and discharged by means of steam traps, as may be required.

156. Auxiliary boiler.—This boiler is to be of the vertical submerged tube pipe, 42 inches in diameter and 9 feet high, with shell extended to form ash pan. All the plates used in the construction of this boiler are to be marine steel of 60,000 to 65,000 lbs. tensile strength. The shell will be $\frac{80}{100}$ inch thick; the fire box and cone will be $\frac{80}{100}$ inch thick, and the heads $\frac{375}{1000}$ inch thick. The shell will be double riveted in the longitudinal seams, and all holes will be drilled; and the fire box and cone will be efficiently stayed for a working pressure of 170 lbs. per square inch. The boiler is to contain about 84 tubes 2 inches in diameter and not less than 42 inches long, and must be built according to the rules of the Board of Supervising Inspectors of Steam Vessels. A chimney of suitable size will be provided with all the necessary casings, deck rings and guys; and the boiler will be set in place, all mountings fitted, and shell covered with approved magnesia nonconductor 2 inches thick, covered with

canvas and painted. The bottom of the shell will have a 2-inch angle-bar ring riveted on the outside and to the base plate, which last is to be made of ½-inch steel plate, square in form, by which the boiler will be secured to deck. The bottom of the ash pan will be lined with brick. The boiler will have three mud ports at the bottom and three on the level of the furnace crown; and will be provided with grate bars, glass water gage, three gage cocks, one 6-inch diameter steam gage with brass case, spring safety valve, blow-off valve, one 1-inch Metropolitan injector, or other of equally good make, fitted to boiler by connection independent of blow-off, and one 2½-inch main steam valve of "extra heavy" pattern.

157. Steam and other gages.—The following gages will be required and must be set in convenient places and be properly mounted and connected, all steam gages will be provided with cocks and siphon pipes:

Three (3) 8½-inch pressure gages to 200 lbs., brass case, for boilers.
One (1) 10-inch pressure gage to 200 lbs., nickel plated, for main steam in engine room.
One (1) 8½-inch pressure gage to 160 lb., nickel plated, for jet pump.
One (1) 8½-inch pressure gage to 80 lb., nickel plated, for main pump.
One (1) 10-inch vacuum gage, nickel plated, for condenser.
Two (2) 6-inch pressure gages to 80 lb., brass case, for operator.
Two (2) 6-inch vacuum gages, brass case, for operator.
One (1) 6-inch pressure gage to 200 lb., brass case, for auxiliary boiler.
One (1) 6-inch pressure gage to 80 lb., for steam heating pipes, for engine room.
One (1) 6-inch pressure gage to 80 lb., nickel plated, in office.
One (1) eight-day clock, nickel plated case, for engine room.

158. Boiler and steam-pipe coverings.—The tops of boilers and the steam drums and connections must be covered with magnesia block of approved quality, 2 inches thick, properly wired, and covered with canvas. All steam pipes must be covered with the same quality of magnesia of the regular thickness, and must be neatly finished at the flanges, connections, and joints, covered with canvas, and painted and banded in the usual manner. The covering must not be put on until boilers and pipes have been tried under steam and everything found to be perfectly tight.

159. Feed and fire pumps.—These will be two Worthington or Blake horizontal duplex pumps, with outside packed plungers about 5 inches diameter and 10 inches stroke, each having a capacity of 80 gallons per minute when running at average working speed. These pumps must have brass bushes in glands and stuffing boxes of water cylinders, and be provided with all lubricators, etc. The pumps are to be arranged in such a manner that either or both can be used for either feed or fire purposes, and straightway valves are to be used in these connections. The suction is to be taken from the hot well and also from the river, for which suitable connections to hull will be made. A fire main will run on each side of house below carlins, with four branches on main deck, four on boiler deck, and four on hurricane deck. Each branch must be fitted with a valve and hose coupling for 2-inch diameter hose. Twelve lengths of 2-inch rubber-lined cotton hose, each 50 feet long, must be supplied, together with 6 nozzles and a hose key, and rack for each branch. All the above fittings and hose must be of approved make.

160. Heater.—A feed-water heater of the usual steamboat type is to be supplied; the feed pipes inside of heater to be drawn brass tubes connected by flanges.

PLUMBING AND TINNING.

161. State rooms.—Each of the three state rooms forward is to be fitted with a marble corner slab, 22 in. × 22 in., 10-in. back and 14-in. basin, nickel-plated brass faucets for hot and cold water, etc., complete.

162. Officers' wash room.—This will be fitted with five iron enameled wash bowls with sectional slabs, with brackets and union stripe nickel plated and nickel-plated faucets for hot and cold water.

163. Officers' bath rooms and closets.—A 5½-foot white enameled roll rim bath tub is to be fitted in each of the bath rooms, with nickel-plated faucets for hot and cold water, and all other accessories complete. One water-closet in forward bath room and two in officers' closet will be fitted with earthenware front outlet plain pedestal bowls, 7-gallon copper lined siphon flush tanks, with nickel-plated flush and supply pipes and double-cover seats. The wood work is to be oak, with plain round corners.

164. Crew's bath rooms.—Two 5½-foot white enameled roll rim bath tubs are to be fitted in the rooms aft of crew's quarters, with all fittings similar to those in officers' bath rooms.

165. Crew's wash room.—The crew's wash room on starboard guard is to be fitted with four iron enameled wash bowls with sectional slab similar to those described for officers' wash room.

166. Crew's closets.—The crew's closet on the port guard aft of paddle box is to be fitted with hopper closets having suitable flushing arrangements, and also an earthenware urinal having a flushing trough inside of paddle box.

167. Sinks.—One iron white enameled sink 40 in. × 20 in. will be placed in pantry, one 30 in. × 20 in. in kitchen, and one 30 in. × 20 in. in laundry, each to be fitted with hot and cold water connections, waste pipes, and brackets for supporting sinks. Traps will not be required for kitchen and pantry sinks, but the waste pipes must be of large size and be run overboard by an independent connection.

168. Workmanship.—All plumbing and pipe fitting will be done in the most workmanlike and sanitary manner, and will be a thoroughly first-class job in every respect. All cold water service pipes will be connected with tank on roof, and the hot water service pipes for all baths and wash rooms will be connected to hot-water tank.

169. Tinning.—Four (4) downspouts from the corners of the pilot house, 1½ inches in diameter; five (5) on each side from skylight roof to hurricane deck, 2 inches in diameter; five (5) on each side of hurricane deck to boiler deck, 2½ inches in diameter; and five (5) scuppers on each side of boiler deck, 3 inches in di meter, will be provided; all to be made of galvanized iron not less than No. 22 B. W. G. The necessary speaking tubes, bell tubes, and trumpets will be provided and fitted up in a complete and first-class manner.

170. Service pipes.—A complete system of hot and cold water pipes will be fitted to all wash basins, baths, and closets throughout the boat. The kitchen, pantry, and laundry hot-water service will be connected to the range boiler.

MISCELLANEOUS.

171. Workshop and machine tools.—The space between the jet pump and bunker will be used as a machine shop and will be fitted up with a vertical engine, 7-inch cylinder and 9 or 10 inch stroke, and all the necessary shafting, hangers, pulleys, and belts for operating all the machines. The following machine tools are to be supplied and must be of approved make:

One (1) double spindle, 24-inch and 40-inch swing screw cutting lathe with compound rest and rod feed. Bed to be 16 feet long, and the lathe to be provided with full set of change gears, which must include wheels for cutting pipe threads, large and small face plates, one 20-inch four-jaw chuck, one 9-inch three-jaw chuck, steady and following rests. The tail stock is to have a set over for turning taper.

One (1) 25-inch swing vertical drill press with back gear, and power feed with quick return motion.

One (1) 18-inch stroke crank shaper with swivel vise.

One (1) Peerless No. 3 improved bolt and pipe threading machine, to cut bolts from ¼ inch up to 2 inches, and pipes from ⅛ inch up to 3 inches, with a full set of both bolt and pipe dies and of machine taps from ¼ inch to 2 inches; the fittings to include cutting-off knife, chuck for gripping nuts, and holder for taps; all threads to be U. S. standard.

One (1) emery grinder with two wheels, 12 in. × 2 in., and rests suitable for tool grinding.

Two (2) portable vise benches, one 6 ft. × 3 ft. fitted with two vises and two drawers, and one 3½ ft. × 2½ ft. fitted with one vise; these benches to be fi.ted up in a very substantial manner.

One (1) blacksmith's forge, 28 in. × 40 in., with fan blower; to be set up and provided with necessary smoke stack, etc.

172. Small tools.—The following small tools are to be supplied and must be of first-class quality throughout, and of approved make unless otherwise specified:

One (1) anvil, 200 lb.
One (1) set of firing tools for each battery of boilers.
One (1) set of firing tools for auxiliary boiler.
Twelve (12) short-handled coal shovels.
Two (2) long-handled coal shovels.
One (1) set of drop-forged steel wren hes for each engine, machine, and pump.
One (1) set of drop-forged steel wrenches for each capstan engine.
Three (3) machinists' hand hammers.
Twelve (12) machinists' chisels, assorted.
One (1) copper or rawhide hammer.
One (1) blacksmiths' hand hammer, 2 lb. 10 oz. cross peen.
One (1) twelve-pound sledge hammer and handle.
One (1) six-pound sledge hammer and handle.
One (1) set of 12 blacksmiths' tongs.

One (1) set of blacksmiths' tools. (1 set swages, tops and bottoms, ¼ in., 1 in. 1½ in., 2 in., 2½ in., 3 in.; 1 set fullers, tops and bottoms, ½ in., 1 in., 2 in.; 1 flatter, 3 in.; 2 set hammers, 1½ in., 2 in.; 2 cutting chisels, 1 each, hot and cold, 1½ in.; 6 punches, 1 each, square and round, ¼ in., ⅜ in., 1 in.; 1 set heading tools, ⅜ in. to 1 in. by eighths.)
One (1) swage block No. 1, page 284, L. M. Rumsey's catalogue.
Two (2) sleeve ratchets (12 inches), Parker 2, No. 6.
Two (2) boiler ratchets (12 inches), Parker 2, No. 9.
Six (6) steel drills for boiler ratchet, ⅜ in. to 1 in., by eighths.
One (1) medium size melting ladle.
One (1) small size melting ladle.
One (1) portable forge, Buffalo No. 4.
Three (3) machinists' parallel vises, 5½ inch jaws, Prentiss or equal.
One (1) pipe vise, hinged, to take pipe up to 3 inches diameter, No. 10, Plate 599, page 236, L. M. Rumsey's catalogue.
One (1) No. 1 Barnes 3-wheel pipe cutter.
One (1) No. 2 Barnes 3-wheel pipe cutter.
One (1) set of pipe taps, ¼ in., ⅜ in., ½ in., ¾ in., 1 in., 1¼ in., 1½ in., 2 in., 2½ in.
Two (2) pairs No. 1 adjustable pipe tongs, Brown's.
Two (2) pairs No. 2 adjustable pipe tongs, Brown's.
Two (2) pairs No. 4 adjustable pipe tongs, Brown's.
One (1) No. 3½ Brock's chain tongs.
Ten (10) Stilson wrenches, two 6 in., two 8 in., two 14 in., two 24 in., two 36 in.
Twelve (12) Coe's monkey wrenches, wooden handle, two 6 in., two 8 in., two 10 in., two 12 in., two 14 in., two 18 in.
One (1) brass oiler set (6 pieces).
Four (4) oilers, steel, long spout, quart.
Four (4) oilers, steel, long spout, pint.
Four (4) oilers, steel, 3½ inches diameter, 3-inch nozzle.
Three (3) galvanized iron oil tanks, 55 gallons, with pumps, measures, and funnels complete, fig. 699, page 350, M. M. Buck's catalogue.

173. Spare parts of machinery.—The following spare parts are to be furnished; each piece must be fitted in place and all ready for use:

Two (2) bronze sleeves for shaft stuffing boxes of main pump.
Two (2) bronze glands for shaft stuffing boxes of main pump.
Two (2) bronze water rings for shaft stuffing boxes of main pump.
Two (2) bronze worms for hauling winches, one right and one left.
One (1) complete set of linings for main pump, fitted in place.
One (1) complete set of bolts and nuts for securing all liners.
One (1) complete set of patterns for cast linings of casing of main pump.
Twelve (12) nozzles for water jets with ¾-inch outlets.
A full set of grate bars.

174. Steam whistle.—The whistle will be 8 inches in diameter, long bell, and will be placed in position required. The steam pipe will have an independent connection to each battery of boilers, with a shut-off valve to each. The whistle valve will be placed where most convenient and be wired to pilot house.

175. Fire pails.—Four (4) stands for fire pails will be provided and set on the skylight roof, each containing six (6) best galvanized iron fire pails, large size.

176. Water tanks.—A water tank 9 ft. × 3 ft. × 20 in. deep, made of galvanized iron, No. 12 B. W. G., and fitted with iron covers, will be provided for the cold-water service, and a tank of similar size and make, but fitted with a steam-heating coil, will be provided for the hot-water service. Both of these tanks will be placed on hurricane deck. A small expansion tank will be placed in kitchen where convenient, and will receive the water of condensation from coil in hot-water tank by means of a steam trap, and will also have a connection to cold-water tank operated by a ball valve. This tank will work in connection with the boiler of cooking range. The hot and cold water tanks will be supplied by the fire pump, and all connections, valves, and overflow pipes necessary for the complete fitting out of this service will be provided.

177. Steam heating.—A complete system of steam heating will be installed with coils, as follows: Two (2) in office, four (4) in officers' mess room, one (1) in each forward bath and wash room, two (2) in crew's mess room, four (4) in crew's quarters, one (1) in each crew's bathroom, and one (1) in pilot house. The length and numbers of returns of coils will be regulated by the size of rooms to be heated. A reducing valve will be placed near to boiler to reduce the pressure in heating system

to about 25 lb. per square inch; and a spring-loaded relief valve will be placed near end of main line of pipes in engine room, and also a pressure gage in engine room and one (1) in office. The whole will be fitted with all necessary radiator valves, air cocks, steam trap, drainpipes, and screens to protect the woodwork.

178. Flagstaffs.—The forward flagstaff will be placed abaft the pilot house and the after one at end of skylight, properly stepped and braced and furnished with halyards and cleats.

179. Painting.—All woodwork above main deck will be painted three coats of pure white lead and linseed oil. The interior of cabin will be painted with one coat of shellac, three coats of flat color and one of zinc gloss. All knots will receive one coat of shellac. Three (3) name plates for sides of pilot house will be provided, having the name of boat in gilt letters on a dead black ground. The lettering on other parts of boat will be done as directed. In painting metal work, all scales and traces of oxidation must be removed before applying the first coat. The hull will be cleaned by a sand blast and will then receive two coats of red lead and pure linseed oil before launching and the inside will receive one coat of similar paint before launching and another after all work is finished and the bilges cleaned out. The machinery and other ironwork will receive two coats of good oil paint of such colors as may be selected, the last coat to be put on after all work is done and preliminary tests are made.

180. Refrigerating plant.—On the dredge will be installed a refrigerating plant of the type manufactured for steamboats by the Fred. W. Wolf Co., of Chicago, or other of equal quality approved by the engineer officer in charge. This plant will have a capacity sufficient to make about half a ton of ice per 24 hours and cool a storage room about 12 feet long, 4 feet wide, and 7 feet high in the clear. All the machinery must be furnished and installed in a satisfactory manner. The freezing tank is to be provided with ice molds and filter, and tank and storage room must be built in approved manner. It is proposed to place the ice tank on the starboard guard forward of wheel box and the storage room similarly on the port guard. The machinery is to be located as most convenient when the spaces to be occupied are known. The machine will not be run continuously, but in periods of 6 or 8 hours, with the same stoppage between runs. The plant must be run satisfactorily for four days before being accepted. Specifications and general drawings of this plant must be submitted with proposals as required by paragraph 36.

With the dredge there will be furnished the outfit described below. All articles in the outfit are to be of good, standard grades, suitable for the use intended, and subject to the approval of the engineer officer in charge. When necessary, samples of the articles desired will be shown at this office.

Tools, etc.—

4 anchors, cast iron, with extra wide wrought iron flukes riveted on; standard pattern, weight about 500 lb.
6 axes, with handles; weight about 3 lb.
6 bars, crow, steel, 5 feet long.
2 bars, slash.
1 brace, carpenter, ratchet, 10-inch, polished.
2 brushes, flue, wire, size to fit boiler flues.
2 calipers, machinist: 1 outside, 6-inch; 1 inside, 6-inch.
6 cans, oil: Two 1-gallon.
Two 2-gallon.
Two 3-gallon. (M. M. Buck Mfg. Co.'s catalogue, page 354, fig. 717, 718, 720.)
4 chisels, blacksmith, 6-inch.
2 chisels, carpenter, flat, 1-in.
2 chisels, carpenter, gouge.
1 cutter, cold, blacksmith, 1½-inch.
1 cutter, glass.
1 cutter, hot, blacksmith.
1 cutter, washer, large size, single knife. (M. M. Buck Mfg. Co.'s catalogue, page 315, fig. 619.)
1 pair dividers, machinist, 8-inch, spring.
6 dogs, lathe. (LeCount's, Nos. 3, 5, 7, 9, 11, and 13.)
1 drill, breast. (Miller's Falls, No. 13.)
12 drills, flat, ¼-inch to 1¾-inch by eighths.
12 drills, twist. (Morse, taper shank; sizes $\frac{5}{16}$ inch to 1 inch by sixteenths.)
1 straightedge, steel, 36 inch long, beveled edge.
1 set figures, steel, size $\frac{1}{16}$ inch high, Nos. 0 to 9.
36 files, steel: 12 12-inch bastard, 12 12-inch second cut, 6 12-inch smooth, 6 12-inch mill single cut.

Tools, etc.—Continued.
1 frame, hacksaw, Star, for 10-inch blade.
1 grindstone, with fixtures for hand power, 3-inch face, about 36 in. diameter.
1 hammer, blacksmith, hand, 2 lb.
1 hammer, carpenter.
1 hardy, ¾-inch.
2 hooks, boat.
2 hooks, fire.
1 iron, branding. Letters "U. S. E.", ½ inch high.
4 irons, caulking, medium size.
1 knife, drawing, Keen Kutter, 10-inch blade, polished, wood handle, capped and ferruled.
1 level, carpenter's, 24 inches long, arched top plates, 2 side views.
1 marlin spike, steel, 14 inches long, ½ inch diameter.
1 maul, spike, Verona, No. 6, solid steel, with handle.
4 needles, sail.
2 nozzles, brass, 1 inch small end, socket threaded for 2½-inch iron pipe.
12 oilers, copperized steel, spring bottom, 4-inch, 1½-pint.
1 palm, sailor.
6 picks, Verona, double-pointed, No. 7.
300 feet pipe, siphon, wrought iron, 1½-inch, with brass ground joint coupling.
1 plane, carpenter's, jack, 18-inch.
1 plane, carpenter's, smoothing, 24-inch.
2 pliers, Stubbs', raised side cutter: 1 6-inch, 1 18-inch.
2 pumps, siphon, Colls', 2-in. suction and discharge.
1 punch, belt, steel, solid, No. 4.
2 rakes, fire.
1 saw, crosscut, 5 ft., 2 handles.
1 screw-driver, 12-inch.
2 sets screw plates, Green River: 1 set No. 1½, 1 set No. 7.
1 set, rivet, No. 4.
1 pair shears, polished, 14 in.
12 shovels, Ames' No. 2, dirt.
4 shovels, scoop, Ames' No. 4, D handle.
1 sieve, sand, 24 in., No. 12.
1 snips, tinners', 8-inch.
2 soldering coppers, iron handles, about 3 lb.
1 square, carpenter's, steel, 24 in.
1 stamp, steel. Letters "U. S. E.", ½ in. high.
1 stock, pipe, with dies complete. (Walworth No. 1, with dies from ¼ in. to 1 in.)
1 set No. 2 solid dies, ¼ in. to 2 in.
1 Forbes' patent hand-pipe machine, No. 1½, adjustable dies for cutting 2½ in. and 3 in. pipe.
24 taps, machinist, taper, standard V thread; sizes ¼ in. to 1¼ in. rough iron sizes.
6 tools, heading, blacksmith, ¼ in., ½ in., ⅝ in., ¾ in., ⅞ in., 1 in.
6 torches, engineer, cast brass, plain. (Fig. 1114, page 497, M. M. Buck Mfg. Co.'s catalogue.)
1 trowel, mason's, 8-in.
12 wrenches, open end, drop-forged from bar steel, single head, No. 1 to 12, inclusive.
2 wrenches, Champion, chain pipe, No. 3.
1 calking mallet.

Crockery and glassware—
6 bakers, earthenware, 6 in.
6 basins, wash, granite iron, 12 in.
6 bottles, oil, small, plain, glass.
2 bowls, berry, glass, 8 in.
48 bowls, soup, earthenware, 1½-pint.
6 bowls, sugar, earthenware, large.
3 bowls, wash, earthenware, plain, 14 in.
1 caster, quadruple plated.
6 glass cruets.
2 chambers, earthenware.
72 cups, coffee, earthenware.
6 dishes, butter, earthenware, medium size.

Crockery and glassware—Continued.
6 dishes, meat, earthenware: 4 8-in. x 12-in., 2 12-in. x 16-in.
2 dishes, pickle, glass.
18 dishes, side, shallow, 3½ in. x 6½ in.
18 dishes, side, shallow, 6 in. x 9 in.
120 dishes, side, deep, 4½ in. x 6 in.
24 dishes, vegetable, 6 in. x 9 in.
24 dishes, vegetable, 7 in. x 10 in.
2 glasses, celery.
2 holders, spoon, glass.
2 holders, toothpick, glass.
6 pitchers, cream, earthenware: 3 1-pint, 3 1-quart.
6 pitchers, syrup, granite.
6 pitchers, syrup, glass.
3 pitchers, wash, earthenware, large size.
6 pitchers, wash, granite, large size.
4 pitchers, water, earthenware, 6 quarts.
36 plates, cake or dessert, 8 in.
72 plates, earthenware, dinner, 10 in.
36 plates, soup, earthenware, 10 in.
60 plates, ice cream, 6 in.
60 plates, tin, 8 in., solid bottom.
72 saucers, 6 in.
12 shakers, S. & P., glass, 6 salt and 6 pepper.
2 stands, cake, glass, 10 in.
1 stand, fruit, glass, 10 in.
36 tumblers, glass, plain, heavy, large size.
24 egg cups.

Table linen, etc.—
36 bars, mosquito, 3 ft. 9 in. wide, 6 ft. 4 in. long, 54 in. high, finest mesh white bobbinet; to be well made, with tape loops for hanging, all edges bound with tape.
150 blankets, double, blue Dobson, heavy weight, 5 ft. 10 in. x 4 ft. 9 in.
7 cloths, table, 72 in. wide, 12 ft. long, 4 red, best Scotch Turkey, 3 white, Scotch linen, bleached damask.
6 jackets, waiter, drill, white: 2 size 38, 4 size 40.
6 aprons, waiter, drill.
36 napkins, white, good quality, 22 in. square.
60 napkins, red, fringed, 14 in. square.
96 pillow slips, white, Utica muslin, 22 in. x 30 in.
48 pillows, feather, 18 in. x 24 in. Live geese feathers, good striped ticking cover.
60 sheets, bed, ¾ size, Utica muslin.
6 spreads, bed, full size.
12 towels, bath, 22 in. x 48 in.
12 towels, hand, 20 in. x 36 in.
36 towels, roller, 18 in. x 96., heavy huckaback.
100 yards handmade Russia crash.

Kitchen and cooking utensils, etc.—
2 beaters, egg, 14 in.
1 bell, dinner, or hand, 8 in.
1 board, wash, zinc, double face.
1 boiler, coffee, heavy, double retinned, copper bottom, 3 gallons.
3 boilers, soup, heavy, double retinned, copper bottom, 5 gallons.
2 boilers, stock, heavy, double retinned, copper bottom, 5 gallons.
1 boiler, wash, No. 9, tin, flat copper bottom, with cover.
1 borer, bung, Enterprise No. 2.
2 bowls, chopping, wood, 16 in.
1 broiler, retinned wire, 16 in. square, for meat.
1 broiler, retinned wire, 16 in. square, for toast.
2 brushes, grease, flat, thin, 3 in. wide, white bristle.
36 brushes, scrub, double wing, with handles, solid back, white tampico center, mixed ends, 11 in. block.
12 buckets, galvanized iron, 12-quart.
1 can, milk, 5-gallon, standard make.
1 chopper, meat, Enterprise No. 10.
1 cleaver, 8 in. steel blade, wood handle.
1 colander, tin, large size.

Kitchen and cooking utensils, etc.—Continued.

30 cups, tin, 1 pint.
4 dippers, granite, 1 pint.
1 dripper, coffee, granite, 2 gallons.
3 faucets, cedar, large size.
2 forks, meat, 2 prong, iron, heavy tinned, about 15 in.
60 forks, table, common, 3 prong, iron, japanned handle.
36 forks, table, quadruple plated, Rogers', large size.
1 freezer, ice cream, White Mountain, 4 gallons.
6 funnels, tin: 3 ½-pint, 2 1-pint, 1 1-quart.
2 molasses gates (Enterprise Mfg. Co., No. 3).
1 almond grater (Wrought Iron Range Co., No. 108).
1 grater, vegetable (Enterprise Mfg. Co., No. 93).
1 griddle, cast iron, 16 in. x 20 in.
3 hods, coal, galvanized iron, 18 in.
6 irons, smoothing or flat, 6 lb.
1 iron, waffle (Wrought Iron Range Co., No. 25).
4 knives, butcher, 10-in. blade, boxwood handle (Wrought Iron Range Co., No. 106).
60 knives, table, common, japanned iron handle.
36 knives, table, silver-plated, Rogers', medium size.
2 ladles, soup, tin, 1 pint.
1 masher, potato, large, wooden.
6 measures, tin, lipped, with handle: 1 1-pint, 1 1-quart, 2 2-quart, 2 1-gallon.
1 mill, coffee, Parker's, No. 1.
2 moulds, muffin, retinned, 12 cups, 14 in. x 10 in. (Wrought Iron Range Co.).
4 nut crackers, silver-plated.
3 pans, bake: 2 full size, 1 one-half size.
3 pans, bread and dish, tin, extra heavy: 1 8-quart, 1 14-quart, 1 21-quart.
2 pans, cake, 12-inch.
5 pans, drip: 1 full size, 4 one-half size, to fit oven of range.
6 pans, frying, extra deep, heavy, polished: 2 9 in. x 2½ in., 2 12 in. x 3 in, 2 14 in. x 3½ in.
24 pans, mess, heavy, retinned: 6 2-quart, 12 3-quart, 6 5-quart.
8 pans, sauce, extra heavy, retinned, straight: 4 2-gallon, 3 1-gallon, 1 3-gallon.
300 clothes pins, wooden, common.
1 pin, rolling, 4 in. x 15 in., maple, solid handle.
1 pot, coffee, 3-quart.
1 pot, tea, 1-gallon.
1 range, cooking, "Home Comfort" (Wrought Iron Range Co., No. 610), with water back, all fittings and one 100-gallon pressure boiler. All stoves will be set up in place with smooth stovepipes and roof ventilators, and have housings, smokestacks, and caps of No. 22 galvanized iron; smokestacks to be so arranged and of such height as not to interfere with pilot house.
2 saws, meat, 18 in.
1 scale, weighing (No. 240, Wrought Iron Range Co.).
6 scoops, retinned, wooden handle (No. 80, Wrought Iron Range Co.).
2 skimmers, retinned, 5 in. with handle.
8 spoons, cooking, retinned, 14 in.
36 spoons, tea, quadruple silver plated.
2 spoons, sugar, quadruple silver plated.
72 spoons, table, common, Meridian ware.
36 spoons, table, quadruple silver plated.
72 spoons, tea, common, Meridian ware.
1 steamer, cook.
1 steel, butcher, 14 in.
1 stove, laundry, "Home Comfort" (No. 3½, Wrought Iron Range Co.).
2 strainers, culinary: 1 fine wire, 1 coarse wire.
1 strainer, tea.
3 tongs, ice.
4 trays, tin, waiter's, japanned, 18 in.
3 tubs, wash, galvanized iron, 20 in. diameter.
2 turners, cake, tin, iron handle, 18 in. (No. 160, Wrought Iron Range Co).
1 wringer, clothes.
1 set Mrs. Pott's sad irons.
1 ice saw.
1 No. 200 ice pick, wood top, japanned blade and stem.

Kitchen and cooking utensils, etc.—Continued.
2 improved wood-handled ice chippers.
1 lemon squeezer, iron, porcelain cup and top.
1 meat saw, Disston, No. 5, 24 in.
1 meat saw, Disston No. 1, 18 in.
1 japanned cake box, 22 in. x 14 in., strong.
2 XXXX 28 in. waiters, japanned.
2 XXXX 24 in. waiters, japanned.
1 hotel egg beater.
1 nutmeg grater.
3 biscuit cutters, XXXX tin, sharpened.
1 bread board.
6 pint pepper boxes.
2 4-in., all bristle pastry brushes.
1 12-in. black bristle flour brush.
1 dipper, tin, 1 quart.
2 dippers, tin, 1 pint.
3 XXXX tin graters, No. 8, No. 10, No. 14.
3 iron griddles, 24 in. x 16 in.
1 soapstone griddle, 8 in. x 14 in., bound.
2 chopping knives.
3 pastry knives.
4 Climax circular can openers.
12 10-in. pie pans.
1 No. 24 deep hotel fry pan.
2 No. 250 8-quart, retinned, hotel sauce pans.
2 No. 150, 6½-quart, retinned, hotel sauce pans.
2 No. 48, 3-quart, retinned, hotel sauce pans.
2 18-in., tin rim, strong flour sieves.
1 No. 180 hotel skimmer.
2 No. 150 hotel skimmers.
4 steamers, XXXX tin, 12 in. square, 7 in. deep, with covers.

Furniture—
28 bedsteads, iron, black enamel finish; head and foot of gas pipe; woven wire mattress; side bars adjustable; posts with iron flanges for fastening to floor; all 3 ft. wide (Simmons Hdw. Co.'s, catalogue, No. 57), 5 single, 22 double in height, 1 triple in height.
36 chairs, kitchen, wooden bottom.
2 covers, table, 2 yds. square.
10 cuspidors, 9 in., granite iron.
2 desks, office, oak, roll top, 54 in. long, top 12 in. high, side drawers each end.
2 dressers, oak top 18 in. x 39 in., 3 drawers 24 in. x 20 in., beveled glass mirror.
2 dusters, feather, 14 in.
4 inkstands, glass, safety.
12 lamps, bracket, glass fount, No. 2 sun burner, japanned iron bracket.
6 lamps, hand, Rochester, metallic, No. 2.
6 lamps, globe, tubular, No. 3, 1½-in. wick (M. M. Buck Mfg. Co.'s catalogue, fig. 1071, page 482).
24 lanterns, No. 7, New Lake and River, hinged top, Government pattern, globes 7 in. high, 2¾ in. at top, 6 in. diameter at center, 4 in. diameter at bottom.
18 looking glasses, 14 in. x 24 in. glass, plain, 2 in. oak frame.
24 mattresses, cotton top, 30 in. wide, standard length.
2 mattresses, felt, Ostermoor & Co., patent elastic felt, 36 in. wide, standard length.
36 mops, handled, 24 oz., No. 1 special yarn.
2 pans, dust.
3 stands, wash, oak, top, 16 in. x 30 in., 2 drawers and cabinet, with towel rack, Scarrett-Comstock Furniture Co., page 2.
2 tables, extension, plain oak, 3½ ft. x 10 ft.
2 tables, office, quartered oak, 2 ft. 6 in. x 4 ft.
3 trimmers, lamp, Barnard's patent.
200 yards (about) Wile's inlaid linoleum, cut and laid as required in cabin, bathrooms, lavatory, pilot house, etc.
6 oak dining chairs, cobler leather seats.
4 extra large rattan, drop arm, reading rockers.
2 revolving stools.
1 ironing board, 6 ft. x 15 in. to 9 in., with blanket and sheet covers.

Miscellaneous—

18 bars, capstan.
1 basket, clothes, willowware, 12 in. high.
3 sets blocks, chain: 1 differential ½ ton, 1 differential 2 ton, 1 screw hoist 4 ton.
6 blocks, double, wood, heavy, inside strap, loose hoop, iron sheaves, with becket, roller bushed: 2 8-in., 2 10-in., 2 14-in.
4 blocks, snatch, iron: 2 10-in., 2 16 in.
6 blocks, triple, wood, heavy, inside strap, loose hook, iron sheave, roller bushed, with becket: 2 8-in., 2 10-in., 2 14-in.
3 boats, row, oak: 2 24 ft. long, 5 ft. wide; 1 17 ft. long, 4 ft. 10 in. wide; long boats fitted for 6 oars, short boats fitted for 4 oars.
12 pair boots, rubber, sizes 8 and 9.
12 brooms, corn, heavy, deck.
36 brooms, corn, regular size, kitchen use.
3 brushes, dust.
1 brush, marking.
12 brushes, paint, flat, 3½ in. wide, all bristle, leather bound, Whiting's special stucco, No. 30.
6 brushes, sash, ½ in., round, all bristle, wire bound.
1 brush, seam.
2 brushes, steel wire, casting, oblong, 2 in. x 8 in.
2 brushes, whitewash, good quality.
3 clocks, 8-day, approved make.
3 coolers, water, porcelain-lined inside cylinder, 4 gallon.
2 extinguishers, Champion fire, 9 in., copper case.
2 fillers, lamp, tin (M. M. Buck Mfg. Co.'s., catalogue, page 352, fig. 705).
1 flag, Engineer, 7 ft. x 5 ft., good quality.
1 flag, National, 7 ft. x 5 ft., good quality.
24 hats, oiled, Lone Fisherman brand, sizes 12-7, 12-7½.
100 feet hose, 2½ in., 50 ft. sections, cotton woven, rubber lined, guaranteed to stand a pressure of 150 lbs. per square inch; each end to be fitted with female coupling threaded with a 2½-in. pipe thread, each coupling to be held in place with 3 bands or clamps on a shank not less than 3 in. in length.
200 feet hose, best rubber, fire, 4-ply, 2½ in. diameter, fitted with female couplings as above.
24 jackets, oiled, Lone Fisherman brand, size 40.
12 pair mittens, rubber, No. 10.
24 oars, ash, hand made, 8½ ft. long.
1 pad, inking, Excelsior, self-inking, No. 2.
1 paulin, 25 ft. x 25 ft., made of 12-oz. Mt. Vernon army standard duck.
12 penholders, wooden.
1 press, letter, 16 in.
1 rod, level, New York.
36 rollers, towel, 2 in. diameter, 20 in. long.
7 coils rope, strictly pure Plymouth manila: 2 coils 1 in. diameter, 2 coils 1¼ in. diameter, 2 coils 1½ in. diameter, 1 coil 2 in. diameter.
1 coil rope (hemp), ¾ in. diameter.
48 sacks, bed, 2 ft. 10 in. wide, 6 ft. 4 in. long, made of best quality striped ticking.
1 safe, office, combination lock, about 24 in. x 30 in. outside, approved make.
1 scale, platform, Fairbanks, 1,000 lb.
10 pounds sponges, boat.
1 tray, blue print, 44 in. x 50 in. galvanized iron, 3 in. deep.
1 typewriter, Smith Premier, No. 3.
6 wheelbarrows, Columbus, tubular, No. 4.
1 pair 12-inch compasses.
1 oil stone, medium size.
2 sounding leads and lines.
2 15-inch roller rulers.
4 rubber mats, 24 in. x 60 in., with name of boat.
1 corrugated rubber mat, about 12 ft. x 3 ft.
1 anneroid barometer, 8-in. face.
1 6-inch Marine spirit compass.
1 Rockwell & Rupel perfection bath, with 1 dozen standard A copy-press sheets.

Miscellaneous—Continued.

1 binocular glass, U. S. Signal Service, 26 lignes, with case and strap.
60 hand grenades.
36 cork life preservers, canvas cover, with straps complete.
2 thermometers.
1 medicine chest, medium size, with scales, spatulas, and all necessary outfit of standard drugs for emergency use of boat away from port.

MASON M. PATRICK,
Captain, Corps of Engineers, Secretary Mississippi River Commission.

MISSISSIPPI RIVER COMMISSION,
OFFICE OF THE SECRETARY,
St. Louis, Mo., April 19, 1899.

APPENDIX 2 C.

SPECIFICATIONS FOR THE CONSTRUCTION OF REFRIGERATING PLANTS, DREDGE IOTA AND LARGE TENDERS FOR MISSISSIPPI RIVER COMMISSION.

SPECIAL CONDITIONS.

36. General.—The work to be contracted for under these specifications is the building, installation, and testing of a refrigerating plant on each of the steam tenders *Sachem, Choctaw, Wynoka, Nokomis, Leota,* and the dredge *Iota.* It will include all the material, tools, and labor necessary for the completion and delivery of the same, together with such material and supplies as may be required for the first charging of the machines; also the services of an expert engineer for operating the plants during the period of testing the same.

37. System.—Each plant to be of the ammonia compression system.

38. Capacity.—Each plant is to have sufficient capacity for making at least half a ton of ice per 24 hours and for cooling a storage room about 13 feet long, 6½ feet wide, and 7 feet high in the clear, when running in periods of 6 or 8 hours with a stoppage of 6 or 8 hours between runs.

39. Compressor and engine.—The compressor to have ample refrigerating capacity for the above requirements, and to be direct connected to a steam engine of sufficient power to operate the same when running at a moderate speed. The compressor and engine must be mounted together upon a substantial bedplate, and may be of either the horizontal or vertical type. All the details of these machines must be of approved designs; all the materials used must be the best of their kinds and suited to the purposes for which they are intended. The lubrication of all parts must be ample and efficient and must be adapted for continuous running if so desired.

40. Fittings and fixtures.—Each machine to be furnished with one oil separator and one liquid receiver, both made of wrought iron and fitted with sight glasses with automatic self-closing valves; all necessary valves, fittings, and connections, including a by-pass for pumping out the different parts of the system: also, all the requisite ammonia pressure and vacuum gauges, steam gauges, etc., neatly connected and mounted in any desired convenient position.

41. Ammonia condenser.—To be of the submerged type, of ample capacity for the requirements of the compressor, and to be made of the best extra heavy pipe. The tank to be preferably circular in form and to be made of steel plate, No. 10, U. S. G. in thickness, stiffened with angle iron rim and provided with overflow and washout connections.

42. Brine tank and coils.—Each brine tank to be made of steel plate $\frac{5}{16}$ inch in thickness, stiffened with angle iron rim and of ample brine carrying capacity to refrigerate the storeroom, in addition to making the required amount of ice per 24 hours. The coils must be amply sufficient for the above purpose, and must be made of extra heavy continuous welded pipe connected to wrought-iron headers and furnished with all necessary valves and connections. The usual framework for supporting covers, and insulated covers for ice molds, of approved construction, to be fitted to tank. The tanks to be perfectly water-tight and efficiently insulated.

43. Ice molds.—Each tank to be fitted with not less than 30 molds of 100 lb. ice capacity each. The molds to be substantially made of galvanized iron, with stiffening bands around the top, made water-tight and smooth on the inside. Three extra molds must be supplied for each plant.

44. *Can filler, etc.*—Each plant to be provided with one automatic can filler with the necessary hose and fittings, one ice tong for lifting molds out of tank, and one thaw basin.

45. *Harvesting crane.*—Overhead cranes to be provided for the convenient harvesting of the ice, the same to be designed to meet the existing conditions on the several boats.

46. *Brine pump.*—The pump for circulating brine in freezing tank and pipes of cold-storage room must be of ample size and approved make and must be brass lined and brass mounted.

47. *Distilling and filtering apparatus.*—Each plant must include the necessary appliances for supplying pure water for the ice cans. For this purpose steam condensers, reboilers, coolers, and filters must be supplied. The coils to be made of galvanized pipe and the tank of heavy galvanized iron or steel. This part of the work must be substantially made and must be complete in all its details. Washout drains must be provided for all tanks, and the filters must be arranged for washing out without disconnecting any pipes.

48. *Stands and framing.*—All stands and frames required for the support of the various parts of these plants must be made entirely of iron or steel and must be efficiently secured to the steel decks of the several boats; and all stiffening plates, braces, stanchions, liners or shim plates required for the adequate securing or support of the said machinery must be supplied and put in place as part of the work included in this contract.

49. *Cold store and brine piping.*—The cold-storage rooms are already built and are 13 feet by 6½ feet by 7 feet high in the clear. The necessary amount of brine piping must be erected in the rooms to maintain a temperature of about 36 degrees Fahrenheit while the machines are running. These coils must be made from piping of the very best quality, must have all necessary valves and connections, must be efficiently secured in place, and provided with drip pans of galvanized iron and drain pipes for same.

50. *Insulating.*—All exposed cold pipes, ammonia or brine, to be thoroughly insulated with frost-proof covering, guaranteed for a period of two years; and such steam pipes as require it are to be covered with genuine magnesia nonconductor.

51. *Painting.*—All parts of the machinery to be well painted before leaving the shop and to receive a finishing coat of such color as may be selected after erection and final completion on board.

52. *Ammonia and brine.*—The first full charge of ammonia and the brine necessary for the efficient operation of the plants must be supplied, together with one ammonia cylinder for each plant.

53. *Testing.*—All coils, pipes, fittings, and vessels in which ammonia is used under pressure must be tested to not less than 300 lb. air or water pressure before leaving the factory, and all work must be made absolutely free from leaks of any kind whatever before the plants will be accepted.

54. *Material and workmanship.*—All materials used in the construction of these refrigerating plants must be the best of their several kinds and suitable for the purposes for which they are used; and should any defects be developed during construction, test, or trial the contractor must at once replace the defective part.

55. *Tools, etc.*—All the requisite winches and spanners, and such special tools as may be necessary for the operation of the plants, must be supplied; also two thermometers and one salinometer for each boat.

56. *Steam and water supply.*—There will be ample steam available for all purposes, at a boiler pressure of at least 125 lb. per square inch. The boiler pressure may be as high as 170 lb. per square inch, and the machinery must be strong enough to work under this higher pressure. Connections can be made to main steam lines within about 20 feet of the compressor. On the five tenders the water will be supplied by the fire pump in engine room, and any required quantity up to 50 gallons per minute can be obtained. On the dredge *Iota* the water will be supplied by a small centrifugal pump, which will also deliver any required quantity up to 50 gallons per minute. The contractor must make all necessary connections to the supply pumps. The temperature of the condensing water will be subject to varying conditions, but the highest summer temperature may be assumed to be about 80 degrees Fahrenheit.

57. *Trial of plants.*—Upon the completion of each plant the contractor will be required to put the same in operation, and after the first ice has been produced, to run for a period of three days, in watches of 6 or 8 hours, with 6 or 8 hours stops between runs. During this time the plant must produce at least 1,000 lb. of ice each 24 hours, and must maintain the cold-storage room at a temperature of 35 to 38 degrees Fahrenheit while the machinery is in operation. Any defects that may appear or any leaks that may develop during these trials must be made good, and a

successful trial run before the plants will be accepted. The expert in charge of these trials will be required to instruct the U. S. engineers as to the method of running and caring for the machinery in all its different parts.

58. Location of boats, etc.—The steam tenders upon which five of the refrigerating plants are to be erected are lying at West Memphis, Arkansas, on the opposite side of the river and at a distance of about 2 miles below Memphis, Tennessee. The nearest available place for receiving shipments of machinery will be the levee, Memphis, Tennessee, and the United States will furnish the use of a barge and steamboat for the transportation of all machinery from Memphis to the boats at West Memphis, but the contractor must load, unload, and handle said machinery entirely at his own risk and expense. The dredge *Iota* is now lying at Grafton, Illinois, but will probably be at Memphis, Tennessee, by the 1st of June, 1900.

59. Time of delivery and completion.—All six refrigerating plants must be delivered, erected, and ready for trial not later than the first day of August, nineteen hundred.

60. Bidders' plans and specifications.—Bidders are required to submit complete plans and detailed specifications of the plants which they propose to furnish.

61. United States plans.—Two plans will be supplied by the United States and marked, respectively, $\frac{\text{M. R. C.}}{680}$, sheet 4, and $\frac{\text{M. R. C.}}{1049}$, sheet 45. These are intended to show the positions to be occupied by the refrigerating apparatus with relation to the other machinery on board the several boats, also the space available, but are *not* intended to indicate the form, size, or location of the individual parts making up the complete plant, as these points are left in the hands of the several bidders, subject only to the conditions hereinbefore specified.

62. Payments.—Upon the completion of each plant, after a satisfactory test and its acceptance by the United States, ninety (90) per centum of the contract price will be paid to the contractor. The remaining ten (10) per centum will be retained for one month, and will then be paid, less any sums required to reimburse the United States for repairs during that period to remedy defects due to imperfect workmanship, of which the engineer in charge shall be the judge.

63. Inspection.—The plants will be subject to inspection, during their manufacture and erection, by an inspector appointed by the United States, and the contractor must give the inspector every opportunity to oversee the work at all stages. Such tests of material as are deemed necessary are to be made, at the expense of the contractor, under the supervision of the inspector. The engineer officer in charge shall have the right to require the immediate removal of any employee of the contractor who is deemed incompetent or otherwise objectionable.

64. Extra work.—It is the intent of these specifications to secure to the United States six refrigerating plants complete in all respects for the work which they are designed to do, and ready for operation. No claim whatever shall at any time be made upon the United States by the contractor for or on account of any extra work or material performed or furnished, or alleged to have been performed or furnished, unless such extra work or material shall have been expressly required in writing by the engineer officer in charge, the prices and quantities thereof having been first agreed upon by the contracting parties and approved by the Chief of Engineers.

65. Omissions, etc.—All necessary adjuncts or attachments properly forming parts of the refrigerating plants, and requisite for their proper and efficient working, shall be understood to be included in these specifications, whether mentioned herein or not, and shall be supplied by the contractor as forming part of the contract. Any doubt as to the meaning of these specifications, or of any drawings or explanations which are furnished the contractor, will be explained by the engineer officer in charge, who shall also have the right to correct any errors in said specifications, etc., when such correction is necessary for the fulfillment of their intention.

66. Expenses.—In case of failure to complete and deliver the refrigerating plants within the time specified, the contractor will be liable and must pay any and all expenses incurred by the United States because of said failure; said expenses to be determined by the engineer officer in charge.

67. Alternative systems.—While the above specifications contemplate the installation of ammonia compressing refrigerating and ice-making plants, bids on other systems will be entertained. All bids must be accompanied by full detailed drawings and specifications, showing just what it is proposed to furnish.

(Drawings, $\frac{\text{M. R. C.}}{680}$, sheet 14, and $\frac{\text{M. R. C.}}{1049}$, sheet 45.)

MASON M. PATRICK,
Captain, Corps of Engineers,
Sec'y Mississippi River Commission.

OFFICE SECRETARY MISSISSIPPI RIVER COMMISSION,
St. Louis, Mo., January 29, 1900.

APPENDIX 2 D.

REPORT OF ASSISTANT ENGINEER A. T. MORROW ON WORK DONE BY THE TOPOGRAPHICAL PARTY UNDER HIS CHARGE, AND ON RECONNAISSANCE MADE BY ASSISTANT ENGINEER GEO. H. FRENCH, DURING THE FIELD SEASON OF 1899.

ST. LOUIS, MO., *February 23, 1900.*

CAPTAIN: I have the honor to submit the following report on the work done by the topographical party under my charge, and reconnaissance made by Assistant Engineer Geo. H. French, during the field season of 1899.

Acting under your orders, I left St. Louis on 30th April and proceeded to Minneapolis, Minn., for the purpose of organizing a party and commencing operations at that place. The first few days of May I spent in arranging for the subsistence of the party and for the commencement of work. A number of assistants and men arrived on 5th May.

Field work was begun on 6th May with five parties in the field. The work done in the vicinity of Minneapolis during the early part of the season consisted of ordinary levels, a series of tapeline measurements to form a basis for topography, and topography, beginning at the upper limit of the work of 1897 and progressing northward. The hydrography was left to be done at the close of the season. The party was quartered at a hotel near the center of Minneapolis, and outlying work was reached by use of the street-car lines. By 17th June as much work was completed in that vicinity as could be done advantageously without the use of boats and camp outfit.

Operations were then transferred to Aitkin, Minn., in order to prosecute the work downstream, thereby taking advantage of the unusually strong current, and to keep the party occupied in that uncultivated part of the country until after the harvest of the grain crops, which until late in the summer would have rendered topographical work impracticable over most of the country to be traversed by the survey. After reaching Aitkin the party was provided with 7 small boats and a camping outfit of 17 tents, mostly small ones to facilitate dividing the party into detachments. Five teams, with teamsters, were employed for the season to move camp from time to time and to transfer subparties to and from their work when the current was too strong to travel advantageously in skiffs. Two additional assistants joined the party, and enough more men were employed to organize a sounding party and to supply a subsistence force.

The party when fully organized was as follows: A. T. Morrow, in charge; Eugene L. Harman, hydrography; W. S. Williams, E. J. Thomas, F. G. Ray, and M. I. Powers, topography; W. C. Lemen, ordinary levels; and E. E. Whitehead, stadia readings to sounding boat. The recorders, cooks, axmen, etc., completed the party, which numbered altogether about 45 men.

At the time the party reached Aitkin the high water, which came a little later this year than usual, was over the banks, rendering any extensive work in that immediate vicinity impracticable. A small amount of topographical work was done about the town of Aitkin while camping arrangements were being completed, and on the 22d the camp was moved down river about 10 miles, where the banks are higher, and the regular work of the season was then taken up. The high water soon subsided and the work progressed without serious hindrance until the latter part of August, when a second rise occurred which carried the water over the banks in low places and submerged the islands.

The party at this time had reached the vicinity of Little Falls, where its progress was still further obstructed by a log jam of 3 miles in extent. The shore line work and soundings were for a time suspended and only topography and levels continued. By the time the water had fallen sufficiently to resume shore-line work the party had passed over a stretch of 15 miles of river, the survey of which was left incomplete. From this time until the close of the season all parts of the work were completed together, although in October a third rise occurred which reached the bank-full stage and for a time threatened further interruption. On the 13th November work was completed to the upper limit of the work of 1897, near Minnehaha Park. The party was then disbanded and the outfit shipped back to Aitkin to be stored with other property at that place.

The stretch of river covered by the season's operations is radically different from that below St. Paul. The stream is narrow, with abrupt banks, and has practically no flood-plain. The slope of the river is about 2½ feet per mile on the average and the bed of the stream is mostly a mass of gravel and bowlders, relieved by some rock in place at Little Falls, St. Cloud, and Minneapolis. Under these conditions

steamboat navigation is out of the question as a practical means of transportation. The river, however, is effectively utilized by the logging companies in the transportation of logs from the pineries near the head waters to the mills below. Logs are dumped into the river from railways and turned loose from the upper tributaries in such numbers as to completely monopolize the river at times. These are floated by the current until they become lodged against the banks or against obstructions in the stream, whence they are again set afloat and so kept going until they reach their destination. Local mills along the river are supplied by passing logs through assorting gaps and abstracting logs of certain brands. Above Little Falls a series of cribs has been constructed across the stream to prevent the too rapid passage of logs in times of high water. Here the logs are allowed to jam, and are held until such time as they are needed below. Channels are then opened through the jams and the accumulation of logs is gradually turned loose. In places chutes are blocked with piling and used for holding logs in times of high water and for storing for the winter the surplus at the end of the season. At other places long rows of piling and booms are placed to prevent logs from lodging in undesirable places. At Minneapolis the river above the falls is almost entirely monopolized by the rows of piling, cribs and booms used in assorting and distributing logs. All these obstructions, although essentially incident to this method of utilizing the river for commercial purposes, greatly increased the labor of making our surveys and added most perplexing difficulties to the prosecution of the hydrographical work.

Soundings were taken on transverse lines 100 meters apart and were located by stadia readings from an instrument on shore.

The topographical work covered a strip half a mile wide on each side of the river, and was extended to include towns or greater portions of tributary streams or other important topographical features. The work was done in substantially the usual manner, with more numerous stadia readings to conform to the larger scale on which the work is to be platted. Coordinates of the stadia work were computed as the work progressed, this method of reduction seeming to conform better to the conveniences of camp life than platting on large scale field sheets. About 250 miles of the lines computed were run in stretches between geodetic points, which were about 3 miles apart on the average. So much work done under the varied conditions of an entire season, so accurately checked and run so as to exclude the compensations of work run in circuits, should form some reliable test of the accuracy of practical stadia work. The results will be given hereafter with other data.

My assistants were mostly men of extensive experience in their lines of work, and together constituted a strong force.

The work of the season extended over about 190 miles of river and was accomplished in a little over six months, under conditions that were mostly unfavorable.

Summary showing extent and character of field work.

River (midstream distance) on which survey was completed .....miles..	187
River on which survey was partially completed .....do....	15
Topography .....square miles..	266
Hydrography.....do....	21
Tapeline measurements .....miles..	49.5
Instrumental locations on topography.....	155,620
Elevations determined on topography	136,206
Transit readings in connection with tapeline measurements.....	2,795
Elevations determined by ordinary levels.....	7,937
Soundings	79,873
Stadia readings to locate soundings	29,268
Average number of stadia locations per square mile of area covered.....	542
Average number of stadia elevations determined per square mile of area covered.....	475
Average number of soundings per square mile of hydrography.....	3,768
Average daily number of stadia locations per topographer.....	259
Average daily number of stadia elevations per topographer.....	227
Average area completed daily per topographer.....square mile..	0.48
Average length of stadia lines between geodetic points.....miles..	3.2
Average error of closure of stadia lines (computed) between geodetic points	1 in 1,042

RECONNAISSANCE.

In the latter part of the field season of 1898, when the triangulation had reached the vicinity of Aitkin, Minn., great difficulty was experienced in the prosecution of

the work on account of the flat country and the high timber. As these same conditions prevail over the greater part of the territory lying along the river to the head waters, it has seemed advisable to discontinue triangulation above Aitkin and substitute therefor a series of tapeline measurements along the river to form a basis for topographical work; and as a check on this system of measurements, and for a connection at its terminus, to carry triangulation across the country from Brainerd to the head waters, and thence down river as far as the hills extend. As the distance across the country from Brainerd to the head waters is short compared with the distance along the river from Aitkin to the head waters, and as it seemed probable that the work across country could be carried on in the early part of the season when the roads above Aitkin are impassable, this method of procedure seemed to offer the most satisfactory solution of a difficult problem.

In order to ascertain more fully as to the practicability of these plans and to prepare for their execution, Assistant Engineer George H. French was instructed to make an examination of the country lying between Brainerd and the head waters of the river, and if practicable to lay out a system of triangulation over the same; thence to proceed down river and make such examinations of the river and the country adjacent thereto as would enable him to determine as to the practicability of making the proposed tapeline measurements, and advise concerning the best methods of completing the surveys and the proper equipment for the parties prosecuting them.

He came to my camp on June 21 and was provided with a team and camp outfit. He then proceeded to Brainerd and looked over the country along the Brainerd and Northern Railroad to Walker, thence west to Park Rapids, and north to Lake Itasca, returning, he went south from Park Rapids through the Crow Wing country and then east, reaching my camp at Brainerd on August 2.

It was then decided to lay out a system of triangles following substantially the route traveled on his first trip across the country. This he accomplished in about one month. The system comprises fifteen triangles, with sides averaging about 12 miles in length, and extends to Lake Itasca and down the river about 25 miles to Bemidji. On September 7 he left Lake Itasca in a small boat and made an exploration of the river to Aitkin, where he arrived at the end of the month.

A report of his operations, with descriptions of the country he passed through, has been prepared and will be used for future reference. His investigations have resulted in his approval of the plans outlined above. It is therefore respectfully recommended that work for the coming season be undertaken in accordance therewith.

Respectfully submitted.

A. T. MORROW, *Assistant Engineer.*

Capt. MASON M. PATRICK,
Corps of Engineers, U. S. A.

TABLE No. 1.—*Discrepancies between results of precise and ordinary levels, Aitkin, Minn., to Minneapolis, Minn.*

Between—	Distance.	Discrepancy.	Ordinary levels run by—
	Miles.	*Feet.*	
P. B. M. Court-house and Ⓐ Aitkin, and return	3.0	+.08	W. C. Lemen.
P. B. M. 2 13 and P. B. M. 2 14	3.6	−.05	Do.
P. B. M. 2 14 and T. B. M. 246	1.0	+.02	Do.
T. B. M. 246 and T. B. M. 245	.5	+.06	Do.
T. B. M. 245 and P. B. M. 2 22	2.0	+.09	Do.
P. B. M. 2 23 and T. B. M. 237	2.6	+.09	Do.
T. B. M. 237 and P. B. M. 2 32	1.5	−.05	Do.
P. B. M. 2 33 and P. B. M. 2 31	3.6	+.09	Do.
P. B. M. 2 31 and P. B. M. 2 30	4.1	+.07	Do.
P. B. M. 2 30 and P. B. M. 2 29	3.4	−.06	Do.
P. B. M. 2 29 and P. B. M. 2 28	3.3	−.03	Do.
P. B. M. 2 28 and P. B. M. 2 27	2.9	+.13	Do.
P. B. M. 2 27 and P. B. M. 2 26	5.9	+.11	Do.
Ⓐ North Base and P. B. M. 2 25	3.2	−.01	Do.
P. B. M. 2 25 and P. B. M. 2 24	3.3	+.02	Do.
P. B. M. 2 24 and P. B. M. 2 21	3.2	+.04	Do.
P. B. M. 2 21 and P. B. M. 2 20	3.4	+.04	E. E. Whitehead.
P. B. M. 2 20 and P. B. M. 2 19	3.2	+.13	Do.
P. B. M. 2 19 and P. B. M. 2 18	3.2	+.10	Do.
P. B. M. 2 18 and P. B. M. 2 17	2.8	.00	Do.
P. B. M. 2 17 and P. B. M. 2 16	3.2	−.06	Do.
P. B. M. 2 16 and P. B. M. 2 15	3.1	+.02	Do.
P. B. M. 2 15 and P. B. M. 2 14	3.0	+.11	Do.
P. B. M. 2 14 and P. B. M. 2 13	2.5	+.07	Do.
P. B. M. 2 13 and P. B. M. 2 12	3.1	+.07	Do.
P. B. M. 2 12 and T. B. M. 152	1.7	+.06	Do.
T. B. M. 152 and P. B. M. 2 11	1.3	−.06	Do.
P. B. M. 2 11 and P. B. M. 2 10	3.1	−.04	Do.
P. B. M. 2 10 and P. B. M. 2 9	3.1	+.06	Do.
P. B. M. 2 9 and P. B. M. 2 8	3.0	+.04	Do.
P. B. M. 2 8 and P. B. M. 2 7	3.1	+.07	Do.
P. B. M. 2 7 and P. B. M. 2 6	3.3	+.12	Do.
P. B. M. 2 6 and P. B. M. 2 5	3.2	+.19	Do.
P. B. M. 2 5 and P. B. M. 2 4	3.4	+.14	Do.
P. B. M. 2 4 and P. B. M. 2 3	2.7	+.10	Do.
P. B. M. 2 3 and P. B. M. 2 2	3.8	+.06	Do.
P. B. M. 2 2 and P. B. M. 2 1	2.1	+.02	Do.
P. B. M. 2 1 and P. B. M. 2 0	3.5	+.19	Do.
P. B. M. 2 0 and P. B. M. St. Cloud	2.8	+.15	Do.
P. B. M. St. Cloud and P. B. M. 2 39	.5	+.02	Do.
P. B. M. 2 39 and P. B. M. 2 38	3.0	+.11	Do.
P. B. M. 2 38 and P. B. M. 2 37	3.5	+.10	Do.
P. B. M. 2 37 and P. B. M. 2 36	3.9	+.02	Do.
P. B. M. 2 36 and P. B. M. 2 35	3.3	+.01	Do.
P. B. M. 2 35 and P. B. M. 2 34	3.9	+.15	Do.
B. M. 2 34 and P. B. M. 2 33	5.5	+.20	Do.
B. M. 2 33 and P. B. M. 2 32	3.0	+.09	Do.
P. B. M. 2 32 and P. B. M. 2 31	3.7	+.06	Do.
P. B. M. 2 31 and P. B. M. 2 30	3.1	−.05	Do.
P. B. M. 2 30 and T. B. M. 70	2.1	+.09	Do.
T. B. M. 70 and P. B. M. 2 28	.8	−.01	Do.
P. B. M. 2 28 and P. B. M. 2 27	3.3	−.03	Do.
P. B. M. 2 27 and P. B. M. 2 26	3.0	−.02	Do.
P. B. M. 2 26 and P. B. M. 2 25	3.4	+.05	Do.
P. B. M. 2 25 and P. B. M. 2 24	3.0	−.05	Do.
P. B. M. 2 24 and P. B. M. 2 23	2.9	−.02	Do.
P. B. M. 2 23 and P. B. M. 2 22	4.0	+.08	Do.
P. B. M. 2 22 and P. B. M. 2 21	3.6	+.02	Do.
P. B. M. 2 21 and P. B. M. 2 20	3.0	−.02	Do.
P. B. M. 2 20 and P. B. M. 2 19	3.1	−.03	Do.
P. B. M. 2 19 and P. B. M. 2 18	2.7	−.003	Do.
P. B. M. 2 18 and P. B. M. 2 17	3.9	+.09	Do.
P. B. M. 2 17 and P. B. M. 2 16	2.6	+.02	Do.
P. B. M. 2 16 and P. B. M. 2 15	3.2	+.01	Do.
P. B. M. 2 15 and P. B. M. Gluck	.6	+.00	Do.
P. B. M. Gluck and P. B. M. Great Northern	.3	+.02	Do.
P. B. M. Great Northern and P. B. M. 2 12	2.7	−.14	Do.

Number of ordinary level lines compared with precise levels 67
Average length of ordinary level lines between precise bench marks..miles.. 2.93
Average discrepancy .....feet.. .065

TABLE No. 2.—*Slope of water surface in Mississippi River between stone lines, and some other points, from Fort Snelling Military Reservation to Pine Knoll, near Aitkin, Minn.*

Number of stone line.	Location of stone line or other point.	Total slope between points.	Mid-stream distance between points.	Slope per mile.	Remarks.
		Feet.	*Miles.*	*Feet.*	
253 to 264	1,000 meters below Minnehaha Creek				
	At Lake Street Bridge, Minneapolis	8.48	3.3	2.57	
	250 feet below Washington Avenue Bridge.	16.16	2.5	6.46	Foot of rapids.
	Electric power house	10.19	.7	14.97	Below lower dam.
	Head of St. Anthony Falls	66.79	.7		Includes falls and contiguous dams.
266	Thirty-fourth street, North Minneapolis	3.97	2.6	1.53	
267	Three-fourths mile above Fifty-third avenue N.	4.20	3.2	1.31	
268	One-half mile above Rice Creek	3.06	2.5	1.22	
269	1 mile above mouth of Coon Creek	5.00	3.8	1.32	
270	2½ miles below Anoka Bridge	8.13	2.5	3.25	
271	500 meters above bridge at Anoka	8.31	3.1	2.68	
272	At foot of Clouquet Island	4.31	3.0	1.44	
273	At foot of Goodwins Island	4.76	3.1	1.54	
274	3 miles below Elk River	10.43	3.6	2.90	
275	At Elk River Ferry	3.83	2.7	1.42	
276	At Otsego, Minn	7.57	2.9	2.61	
277	175 meters above Dimmicks Island	11.94	3.3	3.62	
278	3 miles below Monticello	12.00	3.0	4.00	
279	At lower end of Monticello	10.27	2.9	3.54	
280	2 miles above Monticello	8.37	2.8	2.99	
281	5 miles above Monticello	10.90	2.8	3.89	
282	At foot of Bear Island	7.18	3.2	2.23	
283	6 miles below Clearwater	7.19	2.6	2.77	
284	At upper end of old cut-off	3.15	3.9	.81	
285	At Clearwater, Minn	2.87	3.3	.87	
286	3 miles above Clearwater	4.85	3.2	1.51	
287	6 miles below St. Cloud	7.19	3.4	2.11	
288	2½ miles below Normal School building	8.60	3.1	2.78	
	St. Cloud Dam	8.50	2.1	4.05	
	Fall at St. Cloud Dam	14.34			
	Foot of Sauk Rapids	1.21	2.6	.46	At medium stage.
	Head of Sauk Rapids	11.40	.7	16.29	
291	4 miles above Sauk Rapids	8.66	4.4	1.97	
292	1½ miles below Little Rock River	4.30	2.1	2.05	
293	2½ miles above Little Rock River	3.94	3.8	1.04	
294	1½ miles below Rice, Minn	3.34	2.7	1.24	
295	950 meters above Russels Ferry	4.69	3.4	1.44	
296	One mile above Platte River	4.44	3.2	1.39	
297	At North Prairie Ferry	5.18	3.3	1.57	
298	At head of McDougalls Island	8.51	3.1	2.75	
299	One-fourth mile below Cashs Island	18.25	3.0	6.08	
299 to 305	(Survey incomplete, stretch includes Little Falls Dam and Pike Rapids.)				
305	4½ miles below town of Fort Ripley	69.73	17.8	3.92	
306	1½ miles below county line road	15.36	3.1	4.96	
307	One-eighth mile above Nokay Sebie River.	4.32	3.2	1.35	
308	3½ miles above ruins of Fort Ripley	3.08	2.8	1.10	
309	2½ miles below Crow Wing River	2.49	3.2	.78	
310	At old Crow Wing Ferry landing	1.97	3.2	.61	
311	3 miles above old Crow Wing	2.19	3.4	.65	
312	At mouth of Buffalo Creek	2.69	3.2	.84	
313	Lower part of Brainerd	1.37	3.1	.44	
	Brainerd Dam	2.21	2.7	.82	
	Falls at Brainerd Dam	17.78			
315	3⅞ miles above Brainerd Dam	.10	3.7	.03	At medium stage.
316	2½ miles below Rabbit River	.09	2.7	.03	
317	One-half mile above mouth of Rabbit River.	.12	3.0	.04	
318	3½ miles above mouth of Rabbit River	.51	2.8	.18	Back water from Brainerd Dam.
319	One-fourth mile above Dr. Camp's place	.55	3.2	.17	
320	1½ miles below Pine River	1.74	3.4	.51	
321	2½ miles above Pine River	2.73	4.1	.67	
322	Three-fourths mile below Tow Head Rapids.	4.02	3.6	1.12	
323	2 miles below Dean Brook	2.92	4.1	.71	
324	1½ miles above Dean Brook	1.71	3.5	.49	
325	Three-fourths mile above sharp bend at Pine Knoll.	1.50	3.5	.43	
325 to 263	Vicinity of Pine Knoll to vicinity of Minnehaha Park.	496.00	202.00	2.45	
	Pine Knoll (near Aitkin) to St. Anthony Falls.	894.00	195.00	2.02	

TABLE No. 3.—*Approximate elevation above Gulf level at Biloxi, Miss., of some points along the river above Fort Snelling.*

[Water surfaces are reduced approximately to the lowest stage during the summer of 1899.]

	Elevation above sea.
	Feet.
Base of rail on Great Northern R. R. bridge, Minneapolis	826
Base of rail at Great Northern R. R. depot, Elk River	894
Base of rail at Great Northern R. R. depot, Monticello	932
Base of rail at Great Northern R. R. depot, Clearwater	962
Base of rail on Great Northern R. R. bridge, St. Cloud	1,034
Base of rail on Northern Pacific R. R. bridge in upper part of Little Falls	1,118
Base of rail on Northern Pacific R. R. bridge in Brainerd	1,211
Base of rail at Northern Pacific R. R. depot, Aitkin	1,209
Water surface at head of St. Anthony Falls	796
Water surface at Anoka bridge	829
Water surface at Elk River ferry	853
Water surface at Monticello bridge	895
Water surface at Clearwater ferry	934
Water surface at St. Cloud railroad bridge	978
Water surface at Two Rivers (Royalton) bridge	1,029
Water surface at upper end of town of Little Falls	1,104
Water surface at lower mouth of Crow Wing River	1,147
Water surface at Brainerd railroad bridge	1,154
Water surface at mouth of Pine River	1,179

TABLE No. 4.

DESCRIPTIONS OF BENCH MARKS FROM MINNEAPOLIS, MINN., TO NEAR AITKIN, MINN., WITH ELEVATIONS IN FEET ABOVE MEMPHIS DATUM.

For full descriptions of precise level, bench marks, and triangulation stations see Report of 1899, pages 3385 and 3408. Mean Gulf level at Biloxi, Miss., adopted value, is approximately 7.81 feet above Memphis datum.

The tile and pipe marks referred to in the following table consist of: A subsurface mark, which is a vitrified clay slab, 18 by 18 by 4 inches, buried about 3½ feet under ground, with a copper bolt leaded into the center, and a 4-inch iron pipe, 4 feet long, extending above the surface and having a brass cap bearing the inscription "Mississippi River Commission," etc. Around the center of both tile and cap are inscriptions designating the character of the mark, thus: Triangulation station, "U. ◬ S."; precise bench mark, "P. B. M." U. ⊙ S. ordinary benchmark, "B. M." U. ⊡ S.

Bench marks are placed in pairs on lines, called "stone lines," crossing the river at intervals of about 3 miles.

The geographical positions, elevations, and the azimuths and distances between consecutive marks of the same line are determined.

The triangulation marks used as bench marks are such as came within easy reach of the precise level or ordinary level lines.

U. S. E. B. M. Under bluff, on right bank, about one-half mile above Soldiers Home. Elevation cap, 716.16 feet.

STONE LINE 264.

[At Lake Street Bridge, in lower part of Minneapolis.]

$\frac{264}{1}$. Tile and pipe, one-half meter north of south line of Marshall street, 23 meters east of east end of Lake Street Bridge. To $\frac{264}{2}$, 90° 59′, 394 meters. Blazed trees: To 15-inch oak, 36° 10′, 12.9 meters; to 18-inch basswood, 331° 40′, 13.6 meters; to 12-inch oak, 306° 40′, 9.1 meters. Elevation cap on pipe, 830.53 feet; bolt in tile, 826.53 feet.

$\frac{264}{2}$. Tile and pipe, on right bank 17 meters toward river from west abutment of Lake Street Bridge. In line with pair of iron posts third from abutment and 6 meters from the south post. Elevation cap on pipe, 802.52 feet; bolt in tile, 798.74 feet.

"U. ⊡ S." B. M. 1. On west abutment of Lake Street Bridge. Elevation, 822.82 feet.

◬ Powder Horn. Thirty-fourth street and Tenth avenue south, Minneapolis. Elevation cap on pipe, 874.8 feet; bolt in tile, 870.79 feet.

City datum of Minneapolis: Elevation, 718.09 feet.

STONE LINE 265.

[At Twentieth avenue south.]

$2\frac{6}{7}$, P. B. M. In southeast Minneapolis, near right of way of Great Northern Railway, 200 meters below east end of bridge. Elevation cap on pipe, 805.32 feet; bolt in tile, 801.34 feet.

$2\frac{6}{8}$. Copper bolt leaded vertically in next to top stepping stone in rock abutment of Northern Pacific Railway bridge, on river end of abutment. Abutment is on north line of Twentieth avenue south. B. M. marked "U. ⊙ S." Elevation, 822.76 feet.

Base of rail, Minneapolis Union Depot. Elevation, 821.06 feet.

Base of rail, Great Northern passenger station, east Minneapolis. Elevation, 811.74 feet.

Base of rail, Kenwood station, Minneapolis and St. Louis Railroad. Elevation, 873.06 feet.

Base of rail, Minnehaha railway station. Elevation, 821.59 feet.

Base of rail, east end Chicago, Milwaukee and St. Paul Railway bridge. Elevation, 848.31 feet.

Base of rail, west end Northern Pacific Railway bridge. Elevation, 825.37 feet.

Base of rail, east end Minnesota and Wisconsin Railroad bridge. Elevation, 813.52 feet.

Base of rail, east end Stone Arch Bridge. Elevation, 812.12 feet.

Base of rail, east end Great Northern Railway bridge. Elevation, 833.91 feet.

Ⓐ Windom, near Windom Park, northeast Minneapolis. Elevation cap on pipe, 963.45 feet; bolt in tile, 959.47 feet.

STONE LINE 266.

[At Thirty-fourth street, north Minneapolis.]

$2\frac{6}{6}$, P. B. M. On top left bank of river at Twenty-seventh avenue, northeast Minneapolis. Elevation cap on pipe, 841.30 feet; bolt in tile, 837.31 feet.

$2\frac{6}{5}$. Tile and pipe, one-fourth meter north of an east and west fence on property belonging to Nelson Reeves. Fence is center line of Thirty-fourth street north in Minneapolis. About 43 meters back from bank of river. Elevation cap on pipe, 828.39 feet; bolt in tile, 824.38 feet.

Ⓐ Peck. Tile and pipe, on top of ridge on Thirty-sixth avenue north, Minneapolis. Elevation cap on pipe, 948.80 feet; bolt in tile, 944.80 feet.

Base of rail on west end Soo Line Railway bridge. Elevation, 841.28 feet.

STONE LINE 267.

[About three-fourths mile above Fifty-third avenue north in Minneapolis and one-fourth mile above center line of section 1, right bank, and section 27, on left bank.]

$2\frac{6}{4}$, P. B. M. On left bank, 130 meters from river at roadside, three-fourths mile above upper limits of Minneapolis. Elevation cap on pipe, 842.74 feet; bolt in tile, 838.78 feet.

$2\frac{6}{3}$. Tile and pipe, on top of right bank on property belonging to J. D. Taylor, 60 meters northeast of Taylor's barn and about 75 meters east of public road. To $2\frac{6}{2}$, 280° 09′, 352 meters. Blazed trees: To 18-inch oak, 5° 40′, 18.2 meters; to 10-inch oak, 207° 25′, 12 meters; to 10-inch oak, 160° 55′, 18.8 meters. Elevation cap on pipe, 834.88 feet; bolt in tile, 830.87 feet.

STONE LINE 268.

[One-half mile above Fridley's mill.]

$2\frac{6}{1}$, P. B. M. Tile and pipe, on left bank, 120 meters back from river and one-half mile above Fridley's mill, at mouth of Rice Creek. Elevation cap on pipe, 858.38 feet; bolt in tile, 854.40 feet.

$2\frac{6}{0}$. Tile and pipe, one-half meter southwest of corner of fence on property of Thomas Warwick, on west side of public road, 480 meters north of Warwick post-office and 400 meters from river. Elevation cap on pipe, 851.76 feet; bolt in tile, 847.78 feet.

STONE LINE 269.

[Two hundred meters above the head of Dunn Island and 1 mile above the mouth of Coon Creek.]

$2\frac{5}{9}$, P. B. M. Tile and pipe, at edge of timber on left bank of river opposite head of Dunn Island, 200 meters from river. Elevation cap on pipe, 846.40 feet; bolt in tile, 842.45 feet.

$2\frac{1}{2}^2$. Tile and pipe, on top of right bank on property belonging to J. Weaver, 260 meters above his house, 1 meter south of a granite bowlder which stands on top of the bank. Elevation cap on pipe, 851.89 feet; bolt in tile, 847.90 feet.

STONE LINE 270.

[About 2¼ miles below the Anoka wagon bridge.]

$2\frac{1}{2}^0$, P. B. M. Tile and pipe, on top of left bank near east and west fence, 145 meters west of section corner 17, 16, 20, 21. Elevation cap on pipe, 867.48 feet; bolt in tile, 863.51 feet.

$2\frac{1}{2}^0$. Tile and pipe on property belonging to C. Peterson, 1½ meters south of his northeast corner, which is at corner of fence on section line, east and west, between sections 28 and 33, T. 119 N., R. 21 W., on west side of road, 255 meters west of right bank of river. To 18-inch oak (blazed), 219° 04′, 7.7 meters, to $2\frac{1}{2}^0$ 239° 55′, 519.6 meters. Elevation cap on pipe, 868.06 feet; bolt in tile, 864.10 feet.

High-water mark at Anoka bridge, spring of 1899. Elevation, 840.76 feet.

STONE LINE 271.

[Five hundred meters above the Anoka wagon bridge.]

$2\frac{1}{2}^1$, P. B. M. Tile and pipe on south side of Rice street, Anoka, 50 meters from river and 550 meters above bridge. Elevation cap on pipe, 853.42 feet; bolt in tile 849.44 feet.

$2\frac{1}{2}^1$. Tile and pipe in Champlin, 500 meters above bridge, 30 meters back of top of bank, one-half meter south of fence on upper line of Frank Johnson's property, at northeast corner of patch of timber. To $2\frac{1}{2}^1$ 201° 36′, 314.6 meters; to 15-inch ash 328° 11′, 4 meters. Elevation cap on pipe, 846.38 feet; bolt in tile, 842.42 feet.

Ⓐ Johnson. Tile and pipe on hill, 3 miles above Champlin, one-fourth mile back of forks of road. Elevation cap on pipe, 942.45 feet; bolt in tile, 938.47 feet.

STONE LINE 272.

[Three miles above Anoka, at foot of Clouquet Island.]

$2\frac{1}{2}^2$, P. B. M. Tile and pipe, 1 meter west of road fence, one-half mile from left bank of river, opposite foot of Clouquet Island. Elevation cap on pipe, 868.44 feet, bolt in tile, 864.48 feet.

$2\frac{1}{2}^2$. Tile and pipe on right bank, 100 meters below the foot of Clouquet Island, on top of high bank, 6½ meters back of fence running along slope of bank, on grassy spot where bank makes a sharp turn. To $2\frac{1}{2}^2$ 188° 03′, 1,017.8 meters. Blazed trees: To 10-inch oak, 255° 48′, 4.4 meters; to 9-inch oak in corner fence, 155° 58′, 7.2 meters. Elevation cap on pipe, 879.07 feet; bolt in tile, 875.09 feet.

STONE LINE 273.

[About 1 mile below Dayton, Minn., at foot of Goodwins Island.]

$2\frac{1}{2}^3$, P. B. M. Tile and pipe on north side of right of way of Great Northern Railway, three-fourths mile below Itasca Station, and one-fourth mile below schoolhouse. Elevation cap on pipe, 891.32 feet; bolt in tile, 887.35 feet.

$2\frac{1}{2}^3$. Tile and pipe, one-half meter south of wire fence on high grassy knob, on property of Alex. Bouley and Hubert Thibodeau, 70 meters back of chute behind Goodwins Island, 100 meters above foot of island, on east brow of hill. Elevation cap on pipe, 900.80 feet; bolt in tile, 896.84 feet.

Ⓐ Carrow. Tile and pipe in edge of timber on high ridge about 1 mile above Dayton, Minn., directly opposite head of Dayton Island. Elevation cap on pipe, 942.27 feet; bolt in tile, 938.30 feet.

STONE LINE 274.

[Three miles below Elk River, Minnesota, and one-fourth mile below Island No. 200.]

$2\frac{1}{2}^4$, P. B. M. Tile and pipe on left bank, one-fourth mile back from river, and 3 miles below Elk River; 275 meters southeast of Stimson's house. Elevation cap on pipe, 897.09 feet; bolt in tile, 893.13 feet.

$2\frac{1}{2}^4$. Tile and pipe on right bank, on upper end of high ridge, 40 meters back from river, on property of Otove Chouinord, one-half meter north of a wire fence running

nearly east and west, on section 26, T. 21 N., R. 23 W. To $2\frac{1}{4}$ 234° 24′, 578.8 meters; to highest point on bowlder, 178° 25′, 6.2 meters; to 3-inch basswood, 77° 55′, 5.8 meters. Elevation cap on pipe, 894.09 feet; bolt in tile, 890.12 feet.

STONE LINE 275.

[One hundred meters below Ferry Landing in lower end of town of Elk River.]

$2\frac{1}{4}$, P. B. M. Tile and pipe in lower part of town of Elk River, one-half meter toward river from right-of-way fence; 150 meters below road leading down hill to ferry. Elevation cap on pipe, 902.71 feet; bolt in tile, 898.75 feet.

$2\frac{1}{4}$. Tile and pipe in pasture, one-fourth meter east of a north and south fence along wagon road running south from ferry, 75 meters from ferry landing, on right bank opposite lower end of town of Elk River, 5 meters south of angle in fence. To $2\frac{1}{4}$ 236° 49′, 313.9 meters; to 18-inch hackberry, 278° 58′, 10.5 meters; to 18-inch ash, 226° 48′, 13.8 meters; to 12-inch oak, 174° 18′, 9.7 meters. Elevation cap on pipe, 868.98 feet; bolt in tile, 865.01 feet.

Base of rail at Great Northern depot, Elk River. Elevation, 901.67 feet.

Base of rail at Northern Pacific depot, Elk River. Elevation, 908.01 feet.

STONE LINE 276.

[At Otsego, Minn., 100 meters below ferry.]

$2\frac{1}{4}$, P. B. M. Tile and pipe on east side of road running to ferry landing opposite Otsego, Minn.; 200 meters back from river. Elevation cap on pipe, 908.98 feet; bolt in tile, 905.03 feet.

$2\frac{1}{4}$. Tile and pipe in east and west street in Otsego, Minn., one-half meter south of wire fence along north line of street, 85 meters south of river; 124 meters east of east line of north and south street running to ferry; 10 meters east of line of east side of church. To $2\frac{1}{4}$ 186° 54′, 441.4 meters. Blazed trees: To 10-inch poplar, 307° 00′, 25.8 meters. Elevation cap on pipe, 910.44 feet; bolt in tile, 906.48 feet.

Ⓐ Davis Island. Tile and pipe on top of left bank of river, one-half mile above Otsego Ferry, and one-fourth mile below Davis Island. Elevation cap on pipe, 915.87 feet; bolt in tile, 911.90 feet.

Ⓐ Baker. Tile and pipe on top of high wooded bluff, 3 miles above Otsego, Minn., and directly opposite the head of Dimmicks Island. Elevation cap on pipe, 968.49 feet; bolt in tile, 964.53 feet.

STONE LINE 277.

[One hundred and seventy-five meters above head of Dimmicks Island, and 3 miles above Otsego, Minn.]

$2\frac{1}{4}$, P. B. M. Tile and pipe, on left bank, 100 meters from river and 200 meters above head of Dimmicks Island. Elevation cap on pipe, 902.65 feet; bolt in tile; 898.70 feet.

$2\frac{1}{4}$. Tile and pipe on top of right bank 3 miles above Otsego, Minn., and about 100 meters above the head of Dimmicks Island; 1 meter west of corner of fence, on property of N. E. Baker; in section 11, T. 121 N., R. 24 W.; in northeast corner of cultivated field. Elevation cap on pipe, 922.63 feet; bolt in tile, 918.66 feet.

STONE LINE 278.

[Three miles below lower limit of Monticello and 600 meters above the head of Browns Island.]

$2\frac{1}{4}$, P. B. M. Tile and pipe, 600 meters back from left bank of river, 3 miles below lower end of Monticello; on north side of public road, 270 meters below H. C. Johnson's house. Elevation cap on pipe, 937.30 feet; bolt in tile, 933.39 feet.

$2\frac{1}{4}$. Tile and pipe, 40 meters back from right bank of river, 550 meters above the head of Browns Island; in pasture, 5 meters west of corner of fence; on property of John C. Nelson; section 8, T. 121 N., R. 24 W. Elevation cap on pipe, 924.15 feet; bolt in tile, 920.18 feet.

STONE LINE 279.

[At lower end of the town of Monticello, at the upper limit of a city park used for picnic grounds.]

$2\frac{1}{4}$, P. B. M. Tile and pipe opposite lower end of Monticello, on river side of public road, 90 meters above W. M. Taft's house. Elevation cap on pipe, 944.71 feet; bolt in tile, 940.75 feet.

$\frac{27}{2}$. Tile and pipe in eastern end of Monticello, 130 meters back from old ferry landing on right bank, one-half meter east of west line of Washington street, between First street and Broadway, 68 meters from Broadway. Elevation cap on pipe, 946.83 feet; bolt in tile, 942.86 feet.

Base of rail at Great Northern Railway depot, Monticello. Elevation, 940.03 feet.

STONE LINE 280.

[Two miles above Monticello, Minn., and 1,000 meters below Lanes Island.]

$\frac{28}{1}$, P. B. M. Tile and pipe 460 meters back from left bank of river and 1,000 meters below the foot of Lanes Island, 39 meters south from angle in public road. Elevation cap on pipe, 960.96 feet; bolt in tile, 957 feet.

$\frac{28}{2}$. Tile and pipe 1,000 meters below foot of Lanes Island, in small oak timber on high ridge, 70 meters back from river and about 25 meters above where ridge leaves river, 440 meters below house on property of N. G. Skarman, on section 3, T. 121 N., R. 25 W. To $\frac{28}{1}$ 234° 56′, 635.6 meters; to 4-inch oak 75° 23′, 2.4 meters; to 4-inch oak 18° 08′, 2.6 meters. Elevation cap on pipe, 947.41 feet; bolt in tile, 943.44 feet.

STONE LINE 281.

[Five miles above Monticello and 440 meters above Island No. 163.]

$\frac{28}{1}$, P. B. M. Tile and pipe, 5 miles above Monticello; 900 meters back from left bank of river, in fence corner on west side of public road; on property of Henry Castle. Elevation cap on pipe, 959.45 feet; bolt in tile, 955.47 feet.

$\frac{28}{2}$. Tile and pipe, on right bank, on slope of high ridge near top, 45 meters back from river, one-quarter mile above head of Island No. 163, about 50 meters above a point opposite upper end of piling which runs from left bank to head of Island No. 163. To $\frac{28}{1}$ 196° 23′, 1,175.2 meters. Blazed trees: To 8-inch oak, 270° 06′, 12 meters; to 9-inch oak, 97° 41′, 7.7 meters; to 12-inch oak, 141° 26′, 9.5 meters. Elevation cap on pipe, 965.75 feet; bolt in tile, 961.77 feet.

STONE LINE 282.

[Forty meters below Bear Island.]

$\frac{28}{1}$, P. B. M. Tile and pipe, one-fourth mile northeast of foot of Bear Island, on south side of public road, about 70 meters below John Dyson's house. Elevation cap on pipe, 976.75 feet; bolt in tile, 972.80 feet.

$\frac{28}{2}$. Tile and pipe, on east side of public road, one-half meter from north and south fence, 70.3 meters from corner where this fence turns west on east and west road, 300 meters from top of right bank of river and 95 meters south of John Sende's house; section 14, T. 122, R. 26. Elevation cap on pipe, 956.19 feet; bolt in tile, 952.23 feet.

STONE LINE 283.

[Six miles below Clearwater, at foot of straight reach where river makes a sharp bend to the northeast.]

$\frac{28}{1}$, P. B. M. Tile and pipe, on south side of public road, about 2½ miles above Bear Island and 1½ miles back from left bank of river, 42 meters below forks of road. Elevation cap on pipe, 981.54 feet; bolt in tile, 977.57 feet.

$\frac{28}{2}$. Tile and pipe, about 30 meters back from left bank of river on high ground back of large bunch of ash and box elders, which stands on bank of river; about 150 meters below lower end of high sand ridge which runs nearly straight for 500 meters; about three-fourths mile below Island No. 158. To ⓐ River Bank 340° 55′, 489.1 meters. Blazed trees; to 15 inch oak 74° 16′, 7 meters; to 18 inch oak 167° 11′, 5.6 meters; to 12 inch oak 203° 16′, 6 meters. Elevation cap on pipe, 947.89 feet; bolt in tile, 943.91 feet.

$\frac{28}{3}$ = ⓐ River Bank. Tile and pipe, 150 meters back from right bank of river, on top of high ridge, opposite lower end of straight reach where river makes a sharp bend to the northeast. Elevation cap on pipe, 1002.41 feet; bolt in tile, 998.42 feet.

STONE LINE 284.

[Three miles below Clearwater at cut-off, opposite mouth of Fish Creek.]

$\frac{28}{1}$, P. B. M. Tile and pipe on south side of public road, about 3 miles below Clearwater and about three-fourths mile back from left bank of river, near north and south section line. Elevation cap on pipe, 991.34 feet; bolt in tile, 987.37 feet.

$2\frac{1}{2}^{4}$. Tile and pipe, on left bank of river 3 miles below Clearwater, on high bank. 7 meters back from edge; half mile above cut-off and about 50 meters below high sand mound. Elevation cap on pipe, 971.40 feet; bolt in tile, 967.44 feet.

$2\frac{1}{2}^{4}$. = ⓐ Benson. Tile and pipe on right bank of river, about 3½ miles below Clearwater, on top of high bank southeast of old cut-off. Elevation cap on pipe, 996.64 feet; bolt in tile, 992.70 feet.

Base of rail at Great Northern depot, Clearwater. Elevation, 970.07 feet.

STONE LINE 285.

[275 meters above ferry at Clearwater, Minn.]

$2\frac{1}{2}^{5}$, P. B. M. Tile and pipe, opposite upper end of Clearwater, 250 meters from river, 215 meters above road leading down to ferry; 1½ meters north of fence. Elevation cap on pipe, 966.17 feet; bolt in tile, 962.20 feet.

$2\frac{1}{2}^{5}$. Tile and pipe in Clearwater, 280 meters above the ferry landing; about 140 meters above mouth of Clearwater creek; in lot 5, block 11; 60 meters from river and about 20 meters from railway track; 20 meters from southwest corner of old deserted hotel building, 6 meters from southeast corner of barn. Elevation cap on pipe, 967.98 feet; bolt in tile, 964.02 feet.

ⓐ Clearwater. Tile and pipe on right bank of river about one mile above Clearwater; in oak timber, 15 meters from top of high bank.. Elevation cap on pipe, 1007.47 feet; bolt in tile, 1003.52 feet.

STONE LINE 286.

[About 3 miles above Clearwater, at head of School Section Island.]

$2\frac{1}{2}^{6}$, P. B. M. Tile and pipe, in jack oak timber on left bank of river opposite head of School Section Island, about 3 miles above Clearwater, 230 meters back from river. Elevation cap on pipe, 1,011.54 feet; bolt in tile, 1,007.58 feet.

$2\frac{1}{2}^{6}$. Tile and pipe, 40 meters back from right bank of river, opposite head of School Section Island, 3 miles above Clearwater, Minn.; 50 meters below two large elms that stand on high bank; on property of C. T. Rigsby. Elevation cap on pipe, 959.24 feet; bolt in tile, 955.28 feet.

STONE LINE 287.

[About 6 miles below St. Cloud and about 1 mile below St. Augusta Church.]

$2\frac{1}{2}^{7}$, P. B. M. Tile and pipe, 6 miles below St. Cloud on south side of public road, nearly east of St. Augusta church; at junction of fences, 130 meters north of house of Mrs. Carrie Bowen, one-half mile back from left bank of river. Elevation cap on pipe 1,020.87 feet; bolt in tile, 1,016.92 feet.

$2\frac{1}{2}^{7}$. Tile and pipe, 550 meters back from left bank of river, about 1 mile below point opposite St. Augusta church; one-half meter north of an east and west fence which separates sections 30 and 31; 60 meters east of junction of fences (north and south and east) on high ridge; on property of George Sheffenberg. Elevation cap on pipe, 1,024.52 feet; bolt in tile, 1,020.55 feet.

$2\frac{1}{2}^{7}$ = ⓐ, St. Augusta. Tile and pipe, on top of right bank of river, about one-half mile northeast of St. Augusta church, 380 meters below mouth of Johnson creek. Elevation cap on pipe, 1,022.89 feet; bolt in tile, 1,018.92 feet.

STONE LINE 288.

[About 2½ miles below Normal School at St. Cloud and 300 meters below lower end of "Thousand Islands."]

$2\frac{1}{2}^{8}$, P. B. M. Tile and pipe about 200 meters back of left bank of river, about 300 meters below foot of "Thousand Islands;" one-half meter south of east and west fence, 27½ meters east of junction of fences. Elevation cap on pipe, 1,036.89 feet; bolt in tile, 1,032.93 feet.

$2\frac{1}{2}^{8}$. Tile and pipe, 5 meters back from top of high sand bank on left bank of river about 300 meters below foot of "Thousand Islands;" on property of H. Kilian and about 100 meters above his house; opposite head of Island No. 139; 3 meters west of corner of fence. To $2\frac{1}{2}^{8}$ 239° 00′, 614.6 meters. Blazed trees: to 6-inch oak, 270° 19′, 3.2 meters; to 6-inch oak, 62° 34′, 4 meters; to 5-inch oak, 111° 49′, 6.5 meters. Elevation cap on pipe, 996.94 feet; bolt in tile, 992.99 feet.

STONE LINE 289.

[Three blocks below upper wagon bridge at St. Cloud, Minn.]

$\frac{2}{1}\frac{2}{2}$, P. B. M. Tile and pipe in East St. Cloud, Minn., 530 meters below wagon bridge; 5 meters back from top of bank and 15 meters south of a ravine. Elevation cap on pipe, 1023.16 feet; bolt in tile, 1,019.20 feet.

$\frac{2}{2}\frac{2}{2}$. Tile and pipe, 9 meters north of north line of Third street, on top of right bank of river, about 20 meters back from large pines which stand on slope of bank. To $\frac{2}{1}\frac{2}{2}$ 253° 30′, 272 meters. Blazed trees: to 15-inch oak, 162°, 1.2 meters; to 9-inch oak, 299°, 1.3 meters; to 18-inch oak, 36°, 1.6 meters. Elevation cap on pipe, 1,039.20 feet; bolt in tile, 1,035.21 feet.

St. Cloud City B. M. "Edelbrock." Elevation, 1,045.03 feet.

Base of rail at Great Northern passenger station, St. Cloud. Elevation, 1,050.91 feet.

Base of rail at Great Northern freight depot, St. Cloud. Elevation, 1,047.52 feet.

Base of rail at west end Great Northern Railway bridge, St. Cloud. Elevation, 1,041.69 feet.

Base of rail at Northern Pacific passenger station, East St. Cloud. Elevation, 1,034.31 feet.

Base of rail at Northern Pacific depot, Sauk Rapids. Elevation, 1,013.01 feet.

STONE LINE 290.

[Eighty meters below foot of Clark Island, 1 mile above Sauk Rapids, Minn.]

$\frac{2}{1}\frac{9}{2}$, P. B. M. Tile and pipe on left bank, one mile above Sauk Rapids, in northwest corner of a small cultivated field, 100 meters below foot of Clark Island. Elevation cap on pipe, 1,012.87 feet; bolt in tile, 1,008.91 feet.

$\frac{2}{2}\frac{9}{2}$. Tile and pipe on right bank, about 1 mile above Sauk Rapids, Minn.; 75 meters from river and directly opposite foot of Clark Island; on property of William Connel and 125 meters below his house. Elevation cap on pipe, 1,019.24 feet; bolt in tile, 1,015.26 feet.

STONE LINE 291.

[About 4 miles above the town of Sauk Rapids, at the foot of Watab Rapids.]

$\frac{2}{1}\frac{9}{1}$, P. B. M. Tile and pipe, at corner of fence on west side of public road about 4 miles above town of Sauk Rapids, 125 meters back from left bank of river, at foot of Watab Rapids. Elevation cap on pipe, 1,037.06 feet; bolt in tile, 1,033.08 feet.

$\frac{2}{2}\frac{9}{1}$. Tile and pipe 5 meters back from top of right bank, at foot of Watab Rapids, 520 meters below foot of Millers Island; on high bank, 70 meters below foot of small island, and 20 meters above a small ravine. To $\frac{2}{1}\frac{9}{1}$, 265° 24′, 330 meters. Blazed trees: To 5-inch oak, 181°, 2 meters; to 6-inch oak, 313°, 5 meters; to 6-inch oak, 115°, 6.5 meters. Elevation cap on pipe, 1,027.84 feet; bolt in tile, 1,023.87 feet.

STONE LINE 292.

[About three-fourths mile below a large granite knob known as "Little Rock."]

$\frac{2}{1}\frac{9}{2}$, P. B. M. Tile and pipe on west side of public road about one-fourth mile south of a large granite knob ("Little Rock"); 600 meters east of left bank of river. Elevation cap on pipe, 1,035.04 feet; bolt in tile, 1,031.08 feet.

$\frac{2}{2}\frac{9}{2}$. Tile and pipe on right bank, 60 meters from river, one-half meter east of north and south fence, 65 meters north of corner of fence; opposite foot of slough on opposite side of river, about three-fourths mile below large granite knob, on property of J. S. Stevenson. Elevation cap on pipe, 1,047.77 feet; bolt in tile, 1,043.80 feet.

STONE LINE 293.

[About one-half mile above Brockaway Schoolhouse No. 7, and about 4½ miles below Rice, Minn.]

$\frac{2}{1}\frac{9}{3}$, P. B. M. Tile and pipe 10 meters back from left bank of river, 4½ miles below Rice, Minn., on property of J. H. Anderson. Elevation cap on pipe 1,042.13 feet; bolt in tile, 1,038.15 feet.

$\frac{2}{2}\frac{9}{3}$. Tile and pipe on right bank of river, at junction of fences, 320 meters back from river, 900 meters north of schoolhouse "Brockaway No. 7," at northwest corner of patch of timber, about 500 meters below Mr. Gregory's house. To $\frac{2}{1}\frac{9}{3}$, 253° 30′, 513.7 meters. Blazed trees: To 24-inch oak, 289° 30′, 32.5 meters; to 20-inch oak, 324° 45′, 37.4 meters. Elevation cap on pipe, 1,049.48 feet; bolt in tile, 1,045.49 feet.

River base. Tile and pipe on top of river bank, on west side of public road, about 2 miles south of Rice, Minn., 8 meters south of section line. Elevation cap on pipe, 1,063.52 feet; bolt in tile, 1,059.54 feet.

STONE LINE 294.

[About 1¼ miles below Rice, Minn.]

$2\frac{1}{4}$, P. B. M. Tile and pipe, on east side of public road, about 1½ miles south of Rice, Minn., 275 meters back from left bank of river. Elevation cap on pipe, 1,065.52 feet; bolt in tile, 1,061.54 feet.

$2\frac{1}{4}$. Tile and pipe about 1½ miles south of Rice, Minn., 30 meters back of right bank of river, nearly south of where road from Rice strikes high bank; about 100 meters above a gravel bar and 600 meters above a large island. To $2\frac{1}{4}$, 204° 58′, 490.2 meters. Blazed trees: To 18-inch basswood, 228° 54′, 6 meters; to 15-inch basswood, 40° 54′, 2 meters; to 24-inch basswood, 132° 14′, 18.7 meters. Elevation cap on pipe, 1,030.28 feet; bolt in tile, 1,026.29 feet.

STONE LINE 295.

[Nine hundred and fifty meters above Russells Ferry and one-half mile above road leading west from Rice.]

$2\frac{2}{4}$, P. B. M. Tile and pipe on west side of public road, 460 meters from left bank of river and 520 meters north of road leading west from Rice to Russells Ferry. Elevation, cap on pipe, 1,064.13 feet; bolt in tile, 1,060.16 feet.

$2\frac{2}{4}$. Tile and pipe on right bank, in timber, 7 meters back from top of bank, 1,000 meters above Russells Ferry, 250 meters above junction of roads, 180 meters below fence corner on east side of road. To $2\frac{2}{4}$, 283° 16′, 761.7 meters. Blazed trees: To 12-inch oak, 354° 30′, 3.5 meters; to 8-inch oak, 86° 30′, 6.2 meters; to 12-inch oak, 163° 45′, 8 meters. Elevation cap on pipe, 1,061.77 feet; bolt in tile, 1,057.80 feet.

STONE LINE 296.

[About 1 mile above the mouth of Platte River and 100 meters above Island No. 88.]

$2\frac{3}{4}$, P. M. B. Tile and pipe, 60 meters back from left bank of river, about 1 mile above the mouth of Platte River, opposite head of Island No. 88, 230 meters below house of J. H. Higgins. Elevation cap on pipe, 1,056.14 feet; bolt in tile, 1,052.18 feet.

$2\frac{3}{4}$, Tile and pipe on river side of public road, opposite head of Island No. 88, 100 meters from water's edge, one-half meter south of yard fence, and 11 meters west from southeast corner of yard; 10 meters south of house of John Burggroff, jr. Elevation cap on pipe, 1,074.15 feet; bolt in tile, 1,070.17 feet.

STONE LINE 297.

[At North Prairie Ferry.]

$2\frac{3}{4}$, P. B. M. Tile and pipe 450 meters from left bank of river, of lower end of high ground, 16 meters southeast of public road leading down to North Prairie Ferry. Elevation cap on pipe, 1,076.68 feet; bolt in tile, 1,072.70 feet.

$2\frac{3}{4}$. Tile and pipe on right bank near North Prairie Ferry landing, on southeast side of road leading to ferry, 50 meters from water's edge, 110 meters southeast of house. To $2\frac{3}{4}$, 223° 14′, 660.5 meters. Blazed trees: To 15-inch oak stub, 308° 30′, 9.3 meters; to 15-inch oak stub, 47° 45′, 13.4 meters. Elevation cap on pipe, 1,057.96 feet; bolt in tile, 1,054.01 feet.

STONE LINE 298.

[At head of McDougalls Island, about 1¼ miles above Two Rivers Bridge.]

$2\frac{4}{4}$, P. B. M. Tile and pipe about 500 meters back from left bank of river, opposite head of McDougalls Island, at edge of timber; 300 meters east of north of Peter McDougall's house, on top of high terrace. Elevation cap on pipe, 1,098.66 feet; bolt in tile, 1,094.68 feet.

$2\frac{4}{4}$. Tile and pipe 300 meters back from right bank, one-fourth meter north of an east-and-west line fence between property of John O. Urbanskie and J. Trask, directly east of Urbanskie's buildings and west of McDougalls Island; 213 meters east of an elm tree which stands in line of fence. Elevation cap on pipe, 1,052.79 feet; bolt in tile, 1,048.86 feet.

STONE LINE 299.

[About 4½ miles above Two Rivers Bridge and about 500 meters below Cashs Island.]

$\frac{299}{1}$, P. B. M. Tile and pipe in timber, 11 meters back from left bank of river; about 4½ miles above the Two Rivers Bridge and about 450 meters below Cashs Island. Elevation cap on pipe, 1,103.31 feet; bolt in tile, 1,099.37 feet.

$\frac{299}{2}$. Tile and pipe at lower end of cultivated field on property of Edw. F. Cash, 470 meters below his house and about the same distance below Cashs Island; about 20 meters back from right bank of river at edge of timber. To $\frac{299}{1}$, 245° 48′, 264.5 meters; to 24-inch basswood (blazed), 140° 40′, 7 meters. Elevation cap on pipe, 1,075.86 feet; bolt in tile, 1,071.90 feet.

STONE LINE 300.

[At head of Island No. 64, 400 meters above mouth of Swan River and 4 miles below Little Falls.]

$\frac{300}{1}$, P. B. M. Tile and pipe 4 miles below Little Falls, on property of Gus Kruger, 40 meters below his house and 30 meters toward river from road. Elevation cap on pipe, 1,114.20 feet; bolt in tile, 1,110.25 feet.

$\frac{300}{2}$. Tile and pipe on right bank 4 miles below Little Falls, on property of Adam Ligman and 20 meters northeast of his house; on high ridge opposite head of Island No. 64; 70 meters from river, 2 meters north of southwest corner of lot fence; 370 meters above mouth of Swan River. Elevation cap on pipe, 1,107.21 feet; bolt in tile, 1,103.24 feet.

STONE LINE 301.

[One mile below the dam at Little Falls, at the head of Island No. 59.]

$\frac{301}{1}$, P. B. M. Tile and pipe 1 mile below the business part of Little Falls, 185 meters toward river from the river road, on south line of property of B. W. Hays, at southwest corner of his field. Elevation cap on pipe, 1,123.60 feet; bolt in tile, 1,119.63 feet.

$\frac{301}{2}$. Tile and pipe on slope of right bank of river about 15 meters back from water's edge, opposite center of Island 59, 10 meters toward river from public road, 145 meters below house of E. Nelson. To $\frac{301}{1}$, 270° 36′, 794 meters. Blazed trees: To 18-inch oak, 86°, 18.4 meters; to 10-inch oak, 114°, 15.4 meters; to 12-inch oak, 306°, 23.8 meters. Elevation cap on pipe, 1,115.48 feet; bolt in tile, 1,111.51 feet.

Base of rail, Northern Pacific Railway Bridge, upper end of Little Falls. Elevation, 1,125.80 feet.

STONE LINE 302.

[One mile above the upper railway bridge at Little Falls.]

$\frac{302}{1}$, P. B. M. Tile and pipe 5 meters back from top of left bank of river, 1 mile above upper railway bridge at Little Falls, in open place in timber, directly across road from old fair grounds. Elevation cap on pipe, 1,129.60 feet; bolt in tile, 1,125.68 feet.

$\frac{302}{2}$. Tile and pipe, on right bank of river, 1 mile above the upper railway bridge at Little Falls, on top of low bank, 15 meters back from water's edge, about 50 meters toward river from wagon road, nearly opposite a junction of wagon roads, about 100 meters upstream from a one-story house, and about 350 meters downstream from a large two-story white brick house. To $\frac{302}{1}$, 272°, 943.8 meters. Blazed trees: To 8-inch elm, 229°, 3.6 meters; to 18-inch basswood, 297° 30′, 5.7 meters; to 15-inch oak 117°, 5.1 meters. Elevation cap on pipe, 1,118.83 feet; bolt in tile, 1,114.85 feet.

STONE LINE 303.

[About 4½ miles above Little Falls, Minn., at Belle Prairie Church.]

$\frac{303}{1}$, P. B. M. Tile and pipe three-fourths meter west of east fence of public road, 44 meters north of line of north wall of Belle Prairie Church, 17 meters north of corner of fence. Elevation cap on pipe, 1,139.42 feet; bolt in tile, 1,135.44 feet.

$\frac{303}{2}$. Tile and pipe at edge of timber on right bank of river, about 200 meters above Roscoe Island and almost directly across river from Belle Prairie Church; about 150 meters back from river bank, on property of William Recicot. To $\frac{303}{1}$, 266°20′, 939.9 meters. Blazed trees: To 6-inch poplar, 313°, 2.7 meters; to 12-inch basswood, 46°, 3.8 meters. Elevation cap on pipe, 1,130.66 feet; bolt in tile, 1,126.70 feet.

STONE LINE 304.

[Three miles above Belle Prairie Church and 1½ miles below Topeka siding on Northern Pacific Railway.]

$\frac{304}{4}$, P. B. M. Tile and pipe on west side of public road, 3 miles above Belle Prairie Church and 1½ miles below Topeka railway station; 15 meters south of house of Leon Bellefeuille. Elevation cap on pipe, 1,147.02 feet; bolt in tile, 1,143.05 feet.

$\frac{304}{3}$. Tile and pipe, on lower end of sand ridge, 15 meters back from top of right bank; one-half mile above Doucette Island and about 350 meters below Island No. 45; about 200 meters above the upper of two creeks on the opposite side of the river. To $\frac{304}{4}$ 242° 39′, 1,057.2 meters. Blazed trees: To 15-inch pine 188°, 4.5 meters; to 15-inch pine 327°, 6.7 meters; to 15-inch pine 76°, 7 meters. Elevation cap on pipe, 1,146.16 feet; bolt in tile, 1,142.17 feet.

STONE LINE 305.

[About 4½ miles below the town of Fort Ripley, Minn., and about three-fourths mile above a sharp bend in river which approaches nearest the railway.]

$\frac{305}{2}$, P. B. M. Tile and pipe, 4½ miles below town of Fort Ripley, on property of D. Branchard, and about 600 meters northwest of his house; one-half meter east of a fence running northwest and southeast; 650 meters back of railroad, and 350 meters from left bank of river. Elevation cap on pipe, 1,153.76 feet; bolt in tile, 1,149.78 feet.

$\frac{305}{1}$. Tile and pipe, on right bank of river, opposite foot of Beseau Bar, 315 meters from river, on side of public road next to river; one meter west of fence, and 25 meters above George Hall's house. To $\frac{305}{2}$ 242°48′, 903 meters. Blazed trees: To 12-inch oak 337°, 31.6 meters; to 10-inch oak 49° 27′, 20.1 meters. Elevation cap on pipe, 1,152.23 feet; bolt in tile, 1,148.23 feet.

STONE LINE 306.

[One and one-fourth miles below old ferry landing, at county-line road, 50 meters below foot of Pipe Island.]

$\frac{306}{4}$, P. B. M. Tile and pipe, 650 meters back from left bank of river, on west side of north and south road; 1¼ miles south of the county line between Morrison and Crow Wing counties; directly abreast of the foot of Pipe Island. Elevation cap on pipe, 1,162.07 feet; bolt in tile, 1,158.08 feet.

$\frac{306}{3}$. Tile and pipe, 100 meters back from right bank of river, 150 meters below foot of Pipe Island; at angle of fence on east side of public road; on top of high ridge 1¼ miles below the old ferry landing, across from the county-line road between Morrison and Crow Wing counties. To $\frac{306}{4}$ 271° 02′, 994.8 meters. Blazed trees: To 4-inch elm 24° 30′, 13.4 meters; to 10-inch (double) elm 85° 12′, 25 meters; to 12-inch basswood 167° 12′, 25.1 meters. Elevation cap on pipe, 1,163.39 feet; bolt in tile, 1,159.42 feet.

STONE LINE 307.

[Two hundred meters above the mouth of Nokay Sebie River and one-half mile above the ruins of old Fort Ripley.]

$\frac{307}{2}$, P. B. M. Tile and pipe one-half meter west of east right of way fence, 170 meters above railroad bridge over the Nokay Sebie River; 8 meters south of south line of house standing across railway track; about 1 mile above railway station of Fort Ripley. Elevation cap on pipe, 1,171.87 feet; bolt in tile, 1,167.89 feet.

$\frac{307}{1}$. Tile and pipe, 30 meters back from right bank, in open grassy spot, 50 meters above the ferry landing; 600 meters above blockhouse at old Fort Ripley; about 100 meters above a point opposite to the mouth of the Nokay Sebie River. To $\frac{307}{2}$ 250° 49′, 341.1 meters. To 9-inch elm (blazed) 42° 10′, 35.2 meters. Elevation cap on pipe, 1,156.69 feet; bolt in tile, 1,152.70 feet.

STONE LINE 308.

[Three and one-half miles above old Fort Ripley.]

$\frac{308}{2}$, P. B. M. Tile and pipe, on top of left bank of river, 3 miles above the mouth of Nokay Sebie River; 650 meters southwest of Blackburn's house, and 250 meters below an east and west fence which runs down to river. Elevation cap on pipe, 1,171.25 feet; bolt in tile, 1,167.27 feet.

$\frac{10}{1}$. Tile and pipe on right bank, 3½ miles above the ruins of old Fort Ripley, 11 meters east of wagon road and 20 meters from river. A lone pine tree stands on hill north 20° west and about one-half mile distant. A big clump of small pines stands on left bank about 200 meters below. To $\frac{10}{1}$ 279° 24′, 167.2 meters. To 30-inch elm snag (blazed) 189°, 6.2 meters. Elevation cap on pipe, 1,165.38 feet; bolt in tile, 1,161.41 feet.

STONE LINE 309.

[Two and one-eighth miles below the lower mouth of Crow Wing River.]

$\frac{10}{2}$, P. B. M. Tile and pipe on left bank, 2½ miles below old Crow Wing church; on property of George Smith, 170 meters downstream from his house; 285 meters from river, one-half meter west of a north and south fence. Elevation cap on pipe, 1,194.87 feet; bolt in tile, 1,190.90 feet.

$\frac{10}{2}$. Tile and pipe, on right bank, 2⅛ miles below the lower mouth of Crow Wing River, on top of a high mound, 25 meters back from river, 100 meters below mouth of a small creek and 500 meters above head of Island No. 22. To $\frac{10}{2}$ 330° 53′, 592.5 meters. Blazed trees: To 18-inch pine 314° 50′, 36.7 meters; to 6-inch pine 190°, 9.8 meters. Elevation cap on pipe, 1,186.96 feet; bolt in tile, 1,183 feet.

STONE LINE 310.

[One-half mile above the upper mouth of Crow Wing River, at old ferry landing.]

$\frac{11}{1}$, P. B. M. Tile and pipe, on high ground 210 meters north 10° west of house of Mrs. Bailey, which stands on the site of the old town of Crow Wing; 230 meters from river and opposite the upper mouth of Crow Wing River. Elevation cap on pipe, 1,198.21 feet; bolt in tile, 1,194.24 feet.

$\frac{11}{1}$. Tile and pipe, 35 meters from river, on right bank; 750 meters above the upper mouth of Crow Wing River; on high ground, 40 meters below old Crow Wing ferry landing; on west side of narrowest part of the neck of land between the Mississippi and Crow Wing rivers. To $\frac{11}{1}$ 332° 40′, 598.5 meters. Blazed trees: To 10-inch pine 301°, 7.6 meters; to 8-inch pine 126°, 10.1 meters; to 12-inch pine 191°, 11.5 meters. Elevation cap on pipe, 1,189.06 feet; bolt in tile, 1,185.07 feet.

STONE LINE 311.

[About 3½ miles above upper mouth of Crow Wing River and about 6 miles below lower part of Brainerd.]

$\frac{11}{1}$, P. B. M. Tile and pipe, on left bank, 3½ miles above the upper mouth of Crow Wing River, and about 2 miles north of Crow Wing railway station on Northern Pacific Railway; 20 meters from river, on high ridge, with low ground along river on both sides of B. M. Elevation cap on pipe, 1,188.34 feet; bolt in tile, 1,184.37 feet.

$\frac{11}{1}$. Tile and pipe, on right bank, 6 miles below Brainerd and 3½ miles above upper mouth of Crow Wing River; on top of point of high ridge, 70 meters from river; about 200 meters south of a small lake and one-fourth mile southeast of head of Big Bass Lake. To $\frac{11}{1}$ 331° 17′, 190.1 meters. Blazed trees: To 7-inch pine 103°, 11.3 meters; to 6-inch pine 265°, 5.2 meters; to 7-inch pine 24°, 16 meters. Elevation cap on pipe, 1,205.06 feet; bolt in tile, 1,201.09 feet.

STONE LINE 312.

[Three miles below Brainerd and 50 meters below mouth of Buffalo Creek.]

$\frac{11}{2}$, P. B. M. Tile and pipe, on top of left bank, 3 miles below Brainerd; 85 meters below mouth of Buffalo Creek and 35 meters above head of small island. Elevation cap on pipe, 1,203.17 feet; bolt in tile, 1,199.20 feet.

$\frac{11}{2}$. Tile and pipe, on right bank, 3½ miles below railway bridge at Brainerd; on top of ridge, 20 meters back from river, and 30 meters below mouth of small ravine which is opposite mouth of Buffalo Creek. To $\frac{11}{2}$ 325° 8′, 210.4 meters. Blazed trees: To 10-inch jack pine 290° 30′, 6.7 meters; to 12-inch jack pine 354°, 3.7 meters; to 12-inch Norway pine 146° 30′, 32 meters. Elevation cap on pipe, 1,193.18 feet; bolt in tile, 1,189.21 feet.

STONE LINE 313.

[Six hundred and fifty meters below wagon bridge at Brainerd, Minn.]

$\frac{11}{3}$, P. B. M. Tile and pipe, near southwest corner of Third and Quince streets, Brainerd; 650 meters below wagon bridge, and 220 meters back from left bank of river. Elevation cap on pipe, 1,227.06 feet; bolt in tile, 1,223.09 feet.

$1\frac{1}{2}$. Tile and pipe, on right bank opposite lower part of Brainerd; 600 meters below wagon bridge; 50 meters from river, on bench at foot of high ridge, directly in front of a large water tank standing on top of ridge; 16 meters north 67° west of northwest corner of barn. To $2\frac{1}{2}$ 260° 36′, 390.2 meters. Blazed trees: To 5-inch jack pine 24°, 1 meter; to 5-inch jack pine 152°, 4.2 meters. Elevation cap on pipe, 1,205.50 feet; bolt in tile, 1,201.51 feet.

P. B. M. "Sanitarium." Flat stone and pipe, in southeast corner of grounds of Northern Pacific Railway Hospital. Established by United States Engineer Office at St. Paul. Cap on pipe is marked "U. S. E. B. M." Elevation cap on pipe, 1,219.81 feet; bolt in stone, 1,215.73 feet.

Base of rail, Northern Pacific Railway bridge, Brainerd. Elevation, 1,219.54 feet.

High-water mark, 1896 (above Brainerd dam). Elevation, 1,185.18 feet.

Ⓐ North Base. Tile and pipe, in center of Mill street, Northeast Brainerd, at east side of Brainerd and Northern Railway track, 30 meters north of road leading to dam. Elevation cap on pipe, 1,215.04 feet; bolt in tile, 1,211.06 feet.

STONE LINE 314.

[One-fourth mile above Brainerd dam.]

$1\frac{1}{4}$, P. B. M. Tile and pipe, in Northeast Brainerd, between Brainerd and Northern track and river; 200 meters above road leading to dam, directly west of Brainerd Lumber Company's sawmill. Elevation cap on pipe, 1,216.68 feet; bolt in tile, 1,212.71 feet.

$1\frac{1}{4}$. Tile and pipe, on hillside on right bank, one-fourth mile above Brainerd dam; 40 meters from river, and 20 meters back of railway track used for dumping logs into river; directly opposite sawmill of Brainerd Lumber Company, and 150 meters below small island. Elevation cap on pipe, 1,225.43 feet; bolt in tile, 1,221.45 feet.

STONE LINE 315.

[Three and one-fourth miles above the Brainerd dam.]

$1\frac{1}{2}$, P. B. M. Tile and pipe, on left bank, $3\frac{1}{4}$ miles above Brainerd dam; on ridge about 44 feet above water; 75 meters from river, directly back of low point three-fourths mile above where river becomes narrow. Elevation cap on pipe, 1,226.85 feet; bolt in tile, 1,222.87 feet.

$1\frac{1}{2}$. Tile and pipe, on right bank, $3\frac{1}{4}$ miles above Brainerd Dam, and three-fourths mile above the upper end of a narrow stretch of river; on high ground opposite low point of left bank, and about 390 meters above a high wooded hill across the river; 140 meters above a bay, and 15 meters back from river. To $2\frac{1}{2}$ 278°, 379 meters. Blazed trees: To 15-inch jack pine 88°, 33 meters; to 24-inch Norway pine 222°, 7.5 meters; to 15-inch jack pine 295° 30′, 11.3 meters. Elevation cap on pipe, 1,208.45 feet; bolt in tile, 1,204.47 feet.

STONE LINE 316.

[Six miles above north end of Brainerd and $2\frac{1}{2}$ miles below the mouth of Rabbit River.]

$1\frac{1}{2}$. Tile and pipe, on left bank, $2\frac{1}{2}$ miles below the mouth of Rabbit River; 15 meters from backwater from Brainerd Dam; 200 meters below a thickly wooded point; 250 meters above an island formed by backwater from Brainerd Dam; 275 meters back of original river bank. A prominent wooded hill stands back of B. M. To $2\frac{1}{2}$ 139° 37′, 635 meters. Blazed trees: To 8-inch white pine 37°, 4 meters; to 8-inch jack pine 97°, 5.8 meters; to 20-inch Norway pine 215° 45′, 31.2 meters. (N. B.—This B. M. is marked by P. B. M. tile and pipe, but was not touched on by precise level line.) Elevation (ordinary levels) cap on pipe, 1,188.64 feet; bolt in tile, 1,184.68 feet.

$1\frac{1}{2}$. Tile and pipe, on right bank, $2\frac{1}{2}$ miles below mouth of Rabbit River, on downstream side of a hilly point which projects to the river between two bays formed by backwater from Brainerd Dam; about 200 meters below extreme end of point, opposite island, across river, formed by backwater; 40 meters from backwater. To $2\frac{1}{2}$ 319° 37′, 635 meters. To 18-inch white pine (blazed) 317° 21′, 33 meters. Elevation cap on pipe, 1,209.53 feet; bolt in tile, 1,205.56 feet.

STONE LINE 317.

[One-half mile above the mouth of Rabbit River.]

$1\frac{1}{2}$, P. B. M. Tile and pipe, on left bank, about 650 meters above the mouth of Rabbit River; on ridge about 40 meters north of highest point; 65 meters from river. Elevation cap on pipe, 1,220 feet; bolt in tile, 1,216.04 feet.

$\frac{318}{17}$. Tile and pipe, on right bank, one-half mile above the mouth of Rabbit River, on top of lower end of ridge covered with jack pines; directly opposite small ravine on left bank; 30 meters from river and 10 meters back from top of bank. To $\frac{318}{17}$ 289° 10′, 259.8 meters. Blazed trees: To 9-inch jack pine 342°, 15.1 meters; to 9-inch jack pine 67°, 2.5 meters. Elevation cap on pipe, 1,227.98 feet; bolt in tile, 1.224 feet.

STONE LINE 318.

[Three and one-eighth miles above the mouth of Rabbit River and 1,000 meters below an old cut-off.]

$\frac{319}{18}$, P. B. M. Tile and pipe, on left bank, 3⅛ miles above the mouth of Rabbit River; and 1,000 meters below an old cut-off, on top of high ridge, 100 meters back from river and 75 meters above where ridge leaves river. Elevation cap on pipe, 1,250.89 feet; bolt in tile, 1,246.93 feet.

$\frac{319}{18}$. Tile and pipe, on right bank, 3⅛ miles above the mouth of Rabbit River and 1,000 meters below an old cut-off; on high ridge one-fourth mile back from river; one-half mile south of the lake formed by the cut-off and called, on old maps, "Half-moon Marsh." To $\frac{319}{18}$ 293° 33′, 673 meters. Blazed trees: To 30-inch oak 268°, 78 meters; to 7-inch jack pine 316°, 8 meters; to 6-inch oak 386°, 5.2 meters. Elevation cap on pipe, 1,218.49 feet; bolt in tile, 1,214.52 feet.

STONE LINE 319.

[Six hundred meters above the site of old Indian mission, now Dr. Camp's place.]

$\frac{320}{19}$, P. B. M. Tile and pipe, on left bank, 600 meters above Dr. Camp's house; in timber 30 meters from river; in low ground 700 meters below where high ground leaves river. Elevation cap on pipe, 1,190.11 feet; bolt in tile, 1,186.15 feet.

$\frac{320}{19}$. Tile and pipe, on right bank, on ridge 40 meters from river, 75 meters below mouth of slough, and 600 meters above house of Dr. Camp, which stands on the site of old Indian mission. To $\frac{320}{19}$ 334° 07′, 227.2 meters; to 6-inch oak (blazed) 11°, 11.7 meters. Elevation cap on pipe, 1,203.06 feet; bolt in tile, 1,199.09 feet.

Ⓐ Camp. Tile and pipe, 600 meters northwest of Dr. Camp's house, which stands on site of old Indian mission; 2 meters north of junction of fence with east and west section line; one-half mile east of Mission Lake, on east side of wagon road. Elevation cap on pipe, 1,209.98 feet; bolt in tile, 1,206.02 feet.

STONE LINE 320.

[One and one-half miles below Pine River and three-fourths mile above Foster's house.]

$\frac{320}{20}$, P. B. M. Tile and pipe, on left bank, 1½ miles below the mouth of Pine River and three-fourths mile above Foster's house; on north slope of ridge, 5 meters from river. Elevation cap on pipe, 1,206.86 feet; bolt in tile, 1,202.89 feet.

$\frac{320}{20}$. Tile and pipe, on right bank, 1½ miles below the mouth of Pine River and three-fourths of a mile above Foster's house; 20 meters back from top of bank; on a point where river makes a sharp bend to the south; river at B. M. runs southeast. To $\frac{320}{20}$ 233° 37′, 123.4 meters. Blazed trees: To 15-inch pine 205° 50′, 20.4 meters; to 24-inch oak 4° 16′, 17.6 meters; to 18-inch oak 78° 46′, 7.5 meters. Elevation cap on pipe, 1,196.55 feet; bolt in tile, 1,192.57 feet.

STONE LINE 321.

[Two and one-half miles above the mouth of Pine River and 1 mile below Island Lake.]

$\frac{321}{21}$, P. B. M. Tile and pipe, on left bank, 2½ miles above Pine River and 1 mile below Island Lake, 40 meters from river and 100 meters below high bank. Elevation cap on pipe, 1,199.96 feet; bolt in tile, 1,196.01 feet.

$\frac{321}{21}$. Tile and pipe, on right bank, 2½ miles above Pine River and 1 mile below Island Lake on top of high sand ridge, where ridge terminates on river bank 20 meters back from river, in section 32. To $\frac{321}{21}$ 52° 46′, 126.7 meters. Blazed trees: To 6-inch Norway pine 183°, 19.1 meters; to 15-inch jack pine 312° 30′, 22.4 meters; to 15-inch Norway pine 48° 30′, 7.1 meters. Elevation cap on pipe, 1,223.65 feet; bolt in tile, 1,219.68 feet.

STONE LINE 322.

[Three-fourths mile below Towhead Rapids and one-fourth mile north of north end of Big Rabbit Lake.]

$\frac{322}{22}$, P. B. M. Tile and pipe, on left bank, three-fourths mile below Towhead Rapids, and 300 meters north of north end of Big Rabbit Lake; on bench 54 meters back from river bank. Elevation cap on pipe, 1,205.84 feet; bolt in tile, 1,201.87 feet.

1¼. Tile and pipe, on right bank, three-fourths mile below Towhead Rapids, 10 meters back from top of high sand ridge; directly back of where sand ridge strikes river. Big Rabbit Lake is 500 meters distant across river, and Indian Lake is 600 meters northwest. To 1¾ 334° 52′, 172 meters. Blazed trees: To 15-inch Norway pine 272°, 5.8 meters; to 18-inch white pine 41°, 18.7 meters; to 18-inch Norway pine 172°, 2 meters. Elevation cap on pipe, 1,222.39 feet; bolt in tile, 1,218.41 feet.

Ⓐ Surre. Tile and pipe, on top of high ground one-fourth mile north of the sharp bend in river at Towhead Rapids one-half mile west of mouth of slough just below Surre's ferry. Elevation cap on pipe, 1,289.79 feet; bolt in tile, 1,285.79 feet.

STONE LINE 323.

[At head of Island No. 1, 2 miles below Dean Brook and 1 mile above foot of the big meadow.]

1¾, P. B. M. Tile and pipe, 5 meters back from top of left bank, 40 meters above the head of Island No. 1; 2 miles below Dean Brook, and 1 mile above the foot of the big meadow, at the point where meadow approaches within 110 meters of river. Elevation cap on pipe, 1,217.32 feet; bolt in tile, 1,213.35 feet.

1¾. Tile and pipe, on right bank, 2 miles below the mouth of Dean Brook and 50 meters above the head of Island No. 1 (the only island in the vicinity); 35 meters from river, on a high ridge. The big meadow across river approaches nearest the river at this point. To 1¾ 320° 32′, 170.5 meters. Blazed trees: To 20-inch oak 279° 27′, 32.6 meters; to 20-inch oak 353° 17′, 38.1 meters; to 18-inch white pine 116° 42′, 26.1 meters. Elevation cap on pipe, 1,216.14 feet; bolt in tile, 1,212.17 feet.

Ⓐ Kemres. Tile and pipe, 200 meters back of left bank, one-fourth mile below mouth of Dean Brook; 200 meters south of mouth of small ravine, 60 meters east of ravine, 25 meters east of a line fence. Elevation cap on pipe, 1,218.64 feet; bolt in tile, 1,214.66 feet.

STONE LINE 324.

[One and one-half miles above Dean Brook and 2½ miles below sharp bend at Pine Knoll.]

1¾, P. B. M. Tile and pipe, 8 meters back from top of left bank, 1½ miles above Dean Brook; 80 meters west of north and south road on section line between sections 1 and 2. Elevation cap on pipe, 1,222.67 feet; bolt in tile, 1,218.70 feet.

1¾. Tile and pipe, on right bank, 1½ miles above Dean Brook and 2½ miles below where river makes a sharp bend at Pine Knoll; on high ridge 130 meters back from river, 1½ meters south of a fence, and 16 meters below an angle in same fence; on property of George Bund; in section 22. To 1¾ 344° 17′, 244.6 meters. Blazed trees: To 15-inch white pine 292° 55′, 31 meters; to 15-inch oak 329° 25′, 53.5 meters. Elevation cap on pipe, 1,219.43 feet; bolt in tile, 1,215.46 feet.

Ⓐ Pine Knoll. Tile and pipe, 75 meters back of top of right bank, one-fourth mile below small ravine which opens into river in sharp bend in river at Pine Knoll; on property of James Welton, near his new residence. Elevation cap on pipe, 1,215.81 feet; bolt in tile, 1,211.83 feet.

STONE LINE 325.

[Three-fourths mile above sharp bend in river at Pine Knoll and about 2½ miles below the mouth of Cedar Brook.]

1¾, P. B. M. Tile and pipe, on left bank, three-fourths mile above sharp bend at Pine Knoll; 300 meters above mouth of Wakefield Brook; on high ground, 75 meters back from river; 65 meters below Frank Dotsler's house. Elevation cap on pipe, 1,216.65 feet; bolt in tile, 1,212.68 feet.

P. B. M. "Court-house." Copper bolt leaded horizontally into second course of brick above foundation, at southwest corner of L, on south side of court-house in Aitkin. Elevation horizontal mark in bolt, 1,223 feet.

Base of rail Northern Pacific depot, Aitkin. Elevation, 1,217.05 feet.

Ⓐ Aitkin Tile and pipe, 1 mile southeast of Aitkin, on highest ground on south side of road, 300 meters west of range line. Elevation cap on pipe, 1,275.74 feet; bolt in tile, 1,271.73 feet.

APPENDIX 2 E.

REPORT OF SURVEYOR W. S. WILLIAMS ON PRECISE LEVEL WORK FROM BATON ROUGE, LA., TO MOUTH OF SOUTH PASS, IN 1897–98; FROM FORT ADAMS, MISS., TO BATON ROUGE, LA., AND FROM NEW ORLEANS, LA., TO BILOXI, MISS., IN 1900.

ST. LOUIS, MO., *May 22, 1900.*

CAPTAIN: I have the honor to submit the following report on the field work done by the precise level parties from Baton Rouge, LA., to mouth of South Pass in 1897–98; from Fort Adams, Miss., to Baton Rouge, La., and from New Orleans, La., to Biloxi, Miss., in 1900; also the office reduction and comparison of the final results of these levels.

FIELD WORK FROM BATON ROUGE TO MOUTH OF SOUTH PASS, 1897–98.

A double precise level party was organized for this work and assembled at Baton Rouge December 5, 1897.

The instrumental constants were determined on December 6, 1897, and on December 7 the line was begun at Baton Rouge, where a river crossing was made to connect with P. B. M. XXXII. The work was finished on March 19, 1898. The party was in the field 106 days, or, excluding Sundays and holidays, 89 working days. During this time 203.23 miles of main line and 31.97 miles of side line were run, making a total of 235.2 miles, or an average of 2.64 miles per working day.

Route.—The main line begins at P. B. M. XXXII, in West Baton Rouge, and crosses the river to Baton Rouge; then down the Yazoo and Mississippi Valley Railroad to Carrollton, La.; then through New Orleans over line of bench marks previously established; then down the left bank of the river, following the road behind the levee and the track of the New Orleans and Southern Railroad to Fort St. Phillip; then across the river to Fort Jackson; then down the right bank to Head of Passes; then across Southwest Pass and down the right bank of South Pass 3 miles; then across South Pass and down the left bank of South Pass to the end of the jetties; closing on P. B. M. J, on the light-house.

Bench marks.—All of the Coast Survey bench marks now in existence, except a few on the points at long distances from the railroad, between Baton Rouge and Carrollton were connected with. All the precise level bench marks previously established between Carrollton and mouth of South Pass were connected with except five. One of these had been certainly destroyed and four could not be found.

All of the stone line bench marks near the railroad between Baton Rouge and Carrollton were connected with, and about 17 new bench marks were established at various points where it was thought they would be of use in the future. The descriptions of these bench marks are appended in Tables Nos. 13 and 14, except those which have been fully described in late reports and of which the descriptions are still good.

The gauge bench marks at Baton Rouge, Carrollton, Fort Jackson, Head of Passes, and Port Eads were all connected with; also the gauges at Fort St. Phillip, Fort Jackson, Head of Passes, Port Eads, Garden Island Bay, and East Bay.

River crossings.—Three crossings were made over a wide river by the method of reciprocal leveling. It was found to be extremely difficult to obtain reliable results on account of the conditions prevailing on this part of the river during the winter months; the river water being so much colder than the air causes the latter to boil almost continually and the refraction to change frequently. The best conditions were found to exist when it was very cloudy and the air cool, with a stiff breeze blowing up or down the river; with the air thus kept in motion, the changes in refraction were much less.

The results show that two sets of observations may agree well inside the prescribed limit and still vary considerably from the mean result. For this reason a great number of observations were taken and the mean of all taken for the true result, rather than the mean of two sets that agreed closely. At Baton Rouge, where the crossing was 860 meters wide, observations were taken on three different days under various conditions, 4 results being obtained each day, making 12 results in all; each result is composed of 16 readings across the river, or 192 readings in all. At Fort Jackson observations were taken on two days on a crossing 760 meters wide, 4 results being obtained each day, each consisting of 16 readings across the river, or 128 readings in all. At the head of the Southwest Pass, where the crossing was 660 meters wide, the observations were all taken in one day, 2 results being obtained in the forenoon and 2 in the afternoon, each result consisting of 32 readings across the river, or 128 readings in all.

Instruments.—The instruments used are Kern precise levels Nos. 4 and 5; Kern bubbles Nos. 3, 5, and 9; Fauth bubble No. 214, and Kern precise leveling rods Nos.

XIV, XVII, XVIII, and XIX. Footplates and pins were used for rod supports except in the soft soil below the Jump, where long stakes with nails in the top were used.

Kern bubbles Nos. 3 and 9 were found to be very erratic in their action, probably due to irregular grinding, and a new bubble was obtained from Fauth & Co., Washington, D. C., on December 28, 1897, and used during the rest of the season with entire satisfaction, bubbles Nos. 3 and 9 being discarded.

Instrumental constants.

Instrument.	Date of observation.	Inequality of collars = Cor. P. in mm. per M.	Wire interval in mm. per M.	Remarks.
Telescope No. 4	Dec. 5, 1897	−0.0288	4.29	
Do	Apr. 20, 1898	− .0450	4.29	
Telescope No. 5	Dec. 5, 1897	− .0040	5.25	Wires broken on Mar. 3, 1898, and new set put in.
Do	Apr. 18, 1898	− .0020	4.65	

Value of one division of bubble.

Bubble.	Date of observation.	Value in seconds of arc.	Value in millimeters per M.
Kern No. 3	Dec. 5, 1897	2.50	0.0120
Kern No. 9	Dec. 6, 1897	2.72	.0133
Kern No. 5	Dec. 5, 1897	1.50	.0075
Do	Apr. 18, 1898	1.85	.0090
Fauth No. 214	Jan. 14, 1898	2.54	.0123
Do	Apr. 20, 1898	2.64	.0128

Value of the correction A for rods XIV and XVII is −55.7 millimeters; for rods XVIII and XIX is −56 millimeters. The value of 1 meter on these rods varies so slightly from the standard meter, as ascertained by measurements heretofore taken, that the rod correction has not been taken into account in the computations, as the bench marks differ so little in elevation.

Methods of field work.—The methods pursued are those described in the report of Mississippi River Commission for 1899, page 3469.

Results.—The main line is composed of 314 stretches, the average length of stretch being 1,042 meters. Twenty-six of the 314 stretches in the main line, excluding the three river crossings, failed to close inside the prescribed limits on first trial; 1 of these was closed inside the limit with a third line, 22 with four lines, 2 with five lines, and 1 with six lines. Three side lines failed to close inside the prescribed limits on the first trial, and on these four lines were run. Two results have been rejected on account of their wide divergence from the mean result, probably due to accidental errors; one of these varied 19.7 millimeters and the other 10.52 millimeters from the mean of the other lines in the stretch; three other lines in the first case and four other lines in the second case were run. The results of the first river crossing at Fort Jackson have been rejected on account of the wide range in the individual readings and in the individual results, which show large changes in refraction during the observations. The probable error per kilometer in the main line is ±0.68 millimeter.

FIELD WORK FROM FORT ADAMS, MISS., TO BATON ROUGE, LA., AND FROM NEW ORLEANS, LA., TO BILOXI, MISS.

On the 4th of January, 1900, a double precise level party was organized at Memphis, Tenn. Field work began January 12 and closed March 26, 1900, the party having been in the field 74 days, or, excluding holidays and Sundays, 62 working days. During this time 165.4 miles of main line and 4.3 miles of side line were run, making a total of 169.7 miles, or an average of 2.74 miles per working day.

The party was quartered on the steamer *Patrol* while working from Fort Adams to Baton Rouge. On the stretch from New Orleans to Biloxi the party used two hand cars on the Louisville and Nashville Railroad in going to and from work and in moving from point to point. One hand car was wrecked on March 2; after that date only one hand car was used. The hand cars greatly facilitated the progress of the

work, as the parties were enabled to go to and from work quickly and to work long distances from the stopping places.

Route.—The line from Fort Adams to Baton Rouge commenced at P. B. M. XLIX, in Fort Adams, Miss., and ran to Fort Adams Landing, on the left bank of the river; there a river crossing was made to Point Breeze, Louisiana; the line was then continued down the right bank of the river to P. B. M. XXXII, at West Baton Rouge, La. Two river crossings were made at Fort Adams Landing on two successive days; the first closure was 0.4 millimeter, the second closure was 1.8 millimeters, and the discrepancy between the two crossings was 1.7 millimeters, the width of the crossing being 888 meters.

The line from New Orleans to Biloxi began at P. B. M. City Stone "Halfway House," near Metairie Cemetery, in New Orleans, and ran through the city to the Louisville and Nashville Railroad, at the intersection of Claiborne street and Elysian Fields street; from that point it followed the Louisville and Nashville Railroad to the east side of Biloxi Bay, and closed on P. B. M. E_1. On this line the levels were run over the trestles and bridges at Chef Menteur, The Regolets, Pearl River, Bay St. Louis, and Biloxi Bay in the usual manner, except that nails driven into the trestles were used for turning points, the same turning points being used for direct and reverse lines. Comparisons of the differences obtained between these turning points on the direct and reverse lines show that levels taken in this way are as reliable as those taken on solid ground.

Connections with former levels and new bench marks established.—From Fort Adams to Baton Rouge all of the old precise level bench marks, 18 in number, established by the Coast Survey, were found and connected with except P. B. M. XLII, which is covered up by a large levee; 11 stone line bench marks at various points along the line, and 3 gauge bench marks at Red River Landing, were also connected with, and 7 new P. B. Ms. were established.

From New Orleans to Biloxi 20 old precise level bench marks were found and connected with, and 6 old precise level bench marks have been destroyed. Biloxi Bay tide gauge was inspected and connected with, and 3 new bench marks were established in Biloxi and 1 on the east side of Biloxi Bay to preserve the elevation of the Biloxi Bay tide gauge. One of these bench marks established in Biloxi is especially designed and constructed to be a very permanent mark, and when it has permanently settled it will be connected with and have an inscription placed upon it giving its exact elevation above mean Gulf level.

Instruments.—The instruments used were Kern precise levels Nos. 4 and 5, Kern bubble No. 5, Fauth bubble No. 214, and Kern precise leveling rods Nos. XIV, XVII, XVIII, and XIX. The rod supports for turning points were footplates and pins, pins being used mostly on the stretch from Fort Adams to Baton Rouge and footplates being used mostly on the stretch from New Orleans to Biloxi.

The instrumental constants were determined at the beginning and at the close of the work.

Instrumental constants.

Instrument.	Date of observation.	Inequality of collars=Cor. P. in mm. per M.	Wire interval in mm. per M.
Telescope No. 4	Jan. 12, 1900	−0.0275	4.262
Do	Mar. 26, 1900	− .0604	4.262
Telescope No. 5	Jan. 12, 1900	+ .0062	4.662
Do	Mar. 23, 1900	+ .0040	4.665

Value of one division of bubble.

Bubble.	Date of observation.	Value in seconds of arc.	Value in millimeters per M.
Fauth, No. 214	Jan. 12, 1900	2.25	0.01092
Do	Mar. 26, 1900	2.24	.01085
Kern, No. 5	Jan. 12, 1900	1.72	.0083
Do	Mar. 23, 1900	2.06	.0100

Correction A for rods XIV and XVII is —56 millimeters; for rods XVIII and XIX is 55.7 millimeters. The value of 1 meter on these rods varies so slightly from the standard meter, as determined heretofore, that the rod correction has not

been taken into account in the computations, as the bench marks differ so little in elevation.

Methods of field work.—The methods pursued are those described in the report of Mississippi River Commission for 1899, page 3469.

Results.—The main line from Fort Adams to Baton Rouge is composed of 108 stretches, the average length of stretch being 1,192 meters. Nine of these stretches failed to close inside the prescribed limits on first trial; five were closed with three lines; three were closed with four lines, and on one stretch five lines were run, although the closure was inside the limit with the first four lines. The main line from New Orleans to Biloxi is composed of 108 stretches, the average length of stretch being 1,252 meters. Six of these stretches failed to close inside the prescribed limits on first trial; four were closed with three lines and two with four lines. All side lines run during the season closed inside the limit on first trial.

All results obtained during the season have been retained in the computations, there being no discrepancies large enough to justify their being rejected on account of accidental errors.

The probable error per kilometer in the main line from Fort Adams to Baton Rouge is ±0.63 millimeter, from New Orleans to Biloxi it is ±0.61 millimeter.

OFFICE REDUCTION.

All of the field notes have been carefully rechecked in the office by the observers, and all of the results have been retabulated and computed. To facilitate the computation and put the report into a more convenient form for future reference, the tabulation has been divided into four stretches, as follows: Biloxi, Miss., to New Orleans, La., 1900; New Orleans, La., to mouth of South Pass, 1898; New Orleans, La., to Baton Rouge, La., 1897–98; Baton Rouge, La., to Fort Adams, Miss., 1900.

The datum plane of all elevations given in the tabulation is the adopted mean Gulf level, which reads 6.083 feet on the staff gauge at Biloxi Bay, the relation between this gauge and the surrounding bench marks having been determined in April, 1898, by precise levels, the results of which are given in Table No. 6. All former elevations have been reduced to this datum plane in Tables Nos. 7, 8, 9, and 10. The discrepancies given are due to difference in leveling and changes in the bench marks themselves, either rising or settling.

COMPARISON AND DISCUSSION OF RESULTS.

The results give a comparison between two lines of precise levels over a distance of 405 miles, and over 86 miles of this distance we have the comparison between three lines of precise levels. They afford an interesting study of results obtained by different methods, and as the lapse of time between the various lines varies from five to twenty years they afford important data as to the stability of different kinds of bench marks. They also give important data for settling the question of the subsidence of the delta.

Biloxi Bay to New Orleans.—In Table No. 5 will be found a comparison of the results obtained on the stretch from Biloxi Bay to Carrollton (in the upper part of New Orleans) in 1900, with the results of the two lines of precise levels previously run over this stretch; the elevations are all reduced to the same datum plane.

Some of the large discrepancies on this stretch may be accounted for as follows: P. B. M. 16 is on a heavy brick jail and has probably settled, as the discrepancies show. P. B. M. 6 is a stone post set on a ridge of high ground, which is about 200 meters long and 70 meters wide; this ridge is complely surrounded by a soft salt marsh and isolated from the high ground on the mainland, and it is not at all improbable that the whole ridge has subsided about 97 millimeters since 1886. P. B. M. 3 is on a heavy brick pillar with a small base and has probably settled. P. B. M. 2 is on the brick abutment of a bridge over Bayou St. John; large cracks in the abutment indicate settling in recent years; an electric street car line has been run across this bridge since 1893, which may account for this. P. B. M. Carrollton is on a very heavy brick building and has undoubtedly been settling ever since it was established; by comparison with City B. M. XX Stone it had settled 7 millimeters in 1886 and 56.3 millimeters in 1898.

This leaves only two bench marks connected with in New Orleans in 1898 and 1900 that were established in 1882; these are granite posts that have been set many years; one of them bears the date "1874;" they have every appearance of being stable marks; they are designated as P. B. M. City Stone "Halfway House" and City B. M. XX Stone. City B. M. XX Stone is the only stable bench mark near the end of the stretch on which all three lines touch; its elevation as determined by the lines scope. a com-

1898 and 1900 differ only —3.4 millimeters from the mean elevation by the lines of 1882 and 1886. P. B. M. City Stone "Halfway House" seems to be relatively the highest of the old marks now in existence in New Orleans; it was not connected with in 1886, but the comparison between this bench mark and P. B. M. 2 by precise levels in 1893 shows a discrepancy of only 0.7 millimeters when compared with their difference in 1882 (see Report of Chief of Engineers for 1893, p. 3623), which shows that the relation between these two bench marks had not changed perceptibly from 1882 to 1893; hence we can get a comparison of the three lines at P. B. M. 2 based on the stability of P. B. M. City Stone "Halfway House." Taking the present elevation of P. B. M. City Stone "Halfway House," 1.6391 meters, and adding the difference, 1.1716 meters, obtained in 1893, gives 2.8107 meters for the elevation of P. B. M. 2, which differs only + 3.7 millimeters from the mean elevation obtained by the lines of 1882 and 1886.

The lines of 1886 and 1900, with the exception of P. B. M.'s 6 and 16, as already noted, show a fairly close agreement from Biloxi Bay to P. B. M. 4 at Chef Menteur, the largest discrepancy up to this point being -18.3 millimeters; but the line of 1882 gradually diverges from the other two and reaches its greatest divergence at P. B. M. 4.

From these results we must conclude that there has been no change in the general elevation at New Orleans since 1882, neither rising nor subsidence, when compared with mean Gulf level at Biloxi Bay and the permanent bench marks in that vicinity; therefore the discrepancies shown in Table No. 5, other than those due to probable settling of individual bench marks, are to be accounted for by differences in leveling, such differences being mostly due to the different methods pursued and instruments used in the field work, it being taken for granted that all three lines were run with equal care and skill.

The methods used in 1882 are explained in Mississippi River Commission report for 1883, page 51. They differ from the methods used in 1900 in two important points, viz, each observer did not duplicate his own work, and the order of observing the back and fore sights was always the same, the back sight being taken first at every instrument station. By one observer running all the lines east and the other running all the lines west the mean result of each stretch is affected by the sum of their personal errors of observation—a very uncertain quantity. By not alternating the order of observing back and fore sights at the successive instrument stations, any constant errors due to rising and settling of the instrument and to changes in refraction become cumulative.

The methods used in 1886 are explained in United States Coast and Geodetic Survey Report for 1880, Appendix No. 11, pages 137 and 138, with the important exception noted in United States Coast and Geodetic Survey Report for 1887, Appendix No. 9, page 187. The two independent lines were run in opposite directions by the same observer at different times, sometimes on the same day, but preferably on different days, and the back and fore sights were nearly equal. This method was a decided improvement on the methods previously used by the Coast Survey; but still it did not eliminate instrumental errors completely, owing to the impossibility of perfectly manipulating these sensitive instruments, as will be pointed out later in this report. The report on the work of 1886 does not state whether or not the order of observing back and fore sights was alternated at successive instrument stations; but the length of time during observations at one station by this method introduces errors due to changing refraction which are not eliminated.

The bubbles used in 1886 were not sufficiently sensitive to give the best results; one had a value of 5.7 seconds and the other a value of 4.2 seconds for one division.

New Orleans to Fort Adams.—The first line of precise levels over this stretch was run by the United States Coast and Geodetic Survey in 1880; hence there is a period of from seventeen to twenty years between the two lines of precise levels. The former elevations of bench marks given in the tabulations are the results of the Mississippi River Commission leveling from Biloxi, Miss., to Carrollton, La., and the Coast Survey leveling from Carrollton, La., to Fort Adams, Miss., these elevations being reduced to the adopted mean Gulf level for comparison.

The discrepancy at New Orleans is +34.2 millimeters; at Fort Adams it is +254.4 millimeters, making the discrepancy between the two lines of levels +220.2 millimeters for this stretch of 169 miles. The largest discrepancy between the two lines on this stretch is +271.4 millimeters at P. B. M. XXXIX, opposite Bayou Sara, La., the total discrepancy at this point being +305.6 millimeters. This bench mark is not in first-class condition, as it is on the edge of the river bank and its concrete base has been partially undermined; but this would tend to make it settle, whereas it is 38.6 millimeters high when compared with P. B. M. XXXVIII, and 56.6 millimeters high when compared with P. B. M. XL.

XLII

The discrepancies on this stretch are very irregular, but have a general tendency from the higher elevation in 1897-98 and 1900 until P. B. M. XXXIX is reached. Many

of these irregularities are no doubt due to changes in elevation of the bench marks themselves. Some of these changes are quite apparent. P. B. M. Carrollton has already been discussed. P. B. M. XXIX is under the inner slope of a large levee, and consequently has had a great weight placed upon it, especially during long periods of high water, when the levee is thoroughly saturated. P. B. M. XXXVII is on a brick building and has probably settled. P. B. M. XLVIII may have settled, as the bluff has been sliding into the river in that vicinity. The former elevation of P. B. M. XXX by precise levels is about 1 foot in error, probably due to an error in connecting with it. The comparison is therefore made with its ordinary level elevation.

P. B. M.'s XIII and XIV, on College Point, showed such a decided drop as compared with P. B. M.'s XII and XV on either side, that it was decided to close the circuit around the point with the line across the point on the railroad. This 9 mile circuit closed only 0.3 millimeters high, showing conclusively that the 1897–98 elevations were correct. P. B. M. XIII is on an iron gate post and P. B. M. XIV is on a door step of a large convent building; but if this discrepancy is due to settling they have both settled about the same, as their difference in elevation in 1897–98 differs from that of 1880 by only 1.6 millimeter.

The discrepancy of about 21 millimeters between P. B. M.'s XXXI and XXXII is probably due to the different methods used in making the river crossings at Baton Rouge, La.

All of the variations between these two lines can hardly be ascribed to changes in elevation of the bench marks themselves with reference to the general elevation of the adjacent surface; hence they must be due either to irregular rising or subsiding of the earth's crust or to the variations of the two lines of levels with respect to the true differences of elevation between these points. I am inclined to believe it is the latter, and that these discrepancies are mostly due to the different methods used on the two lines.

The method used in 1880 is fully described in the United States Coast and Geodetic Survey report for 1880, Appendix No. 11, pages 137 and 138. Two lines were run simultaneously, with two rods usually at different distances from the instrument; alternate sections were run in opposite directions; back sights were always read first; the errors of collimation and inclination were eliminated by inverting the telescope and reversing the striding level, and a target was used to read the rod, eight micrometer readings being taken to ascertain the correction to be applied to each rod reading. The bubble used had a value of about 5.7 seconds for one division, which is not sufficiently sensitive for this kind of work.

The objections to this method of observing are as follows: Alternate sections run in opposite directions are not likely to be run under the same conditions, either of the earth's surface and atmosphere, or the observer; indeed, these conditions are more apt to vary widely; all of which are important in eliminating errors due to heating and cooling of the earth's surface, and the personal errors of observation, which are not constant and probably vary with varying conditions. Reading the back sights always first does not eliminate errors due to rising or settling of the instrument and to changes in refraction; this last point is a very important one, as the refraction changes very rapidly along the southern river during the winter months; and considerable time must elapse, when this method is used, between the beginning of the reading of the first back sight and the end of the reading of the last fore sight at all instrument stations. Errors of collimation and inclination can not be perfectly eliminated by inverting the telescope and reversing the striding level, because of imperfect manipulation; it being very seldom that an observer can read a rod with the bubble in a certain position, then remove the striding level, revolve the telescope completely in the wyes, replace the striding level, and obtain the same reading on the rod with the bubble in its original position; which shows that the relation between the line of collimation and the tangent of the bubble is not the same as in the first reading, and that an observer can never be sure that he has eliminated errors completely by this method.

Unequal sights introduce errors due to curvature, refraction, inequality of the collars of the telescope, and changing the focus of the instrument. These are either not constant or impossible of accurate determination, hence they can not be completely eliminated. Refraction is constantly varying and can not be accurately determined; and the collars of the telescope change from wear and the pivot correction is very difficult to determine accurately.

Being sure the relation between the telescope and striding level does not change between back and fore sights, alternating the order of observing back and fore sights, and equalizing the sights is the only accurate method of eliminating errors due to collimation, inclination, curvature, refraction, and inequality of collars of the telescope.

New Orleans to mouth of South Pass.—On this stretch of 114 miles, we have a com-

parison of two precise level lines run by practically the same methods over the same ground under similar conditions, with an interval of from five to five and a half years between them. Leaving out the caps on top of the pipes, which are not exact points for comparison on account of their looseness, we have 95 bench marks upon which both lines touched.

From New Orleans to The Jump, 89.4 miles, the bench marks are behind the levees and thus protected from overflow of the river, except when crevasses occur. Crevasses did occur between P. B. M.'s 22 and 17 at numerous places in 1897, and the results clearly show the effect of these crevasses in causing some of the bench marks to settle. Below The Jump the ground on which the bench marks are located is very low, most of the bench marks being set in mud and water, and during the overflow they are under the water for long periods. The ground is very soft and has either subsided as a whole or the bench marks have settled in the soft mud.

The lines between New Orleans and Fort St. Philip afford the best stretch for comparison. This stretch is 79 miles long and has 66 bench marks common to both lines. The following bench marks, which show large discrepancies, have undoubtedly settled as indicated by comparison with adjacent bench marks and an examination of the conditions surrounding them, and they are therefore not considered in the comparison. P. B. M. 24 is on a large brick building. P. B. M. $^{2}\frac{1}{2}^{L}$ is near a large hole where the ground has subsided, leaving only the tops of the trees above water. A crevasse occurred at P. B. M. 21 in 1897. It is now outside of the new levee and the deposit has filled in around it up to the top of the pipe. A crevasse occurred at $^{2}\frac{1}{2}^{A}$ in 1897.

Leaving these 4 bench marks out of the comparison, we have 3 bench marks that show a higher and 58 that show a lower elevation in 1898 when compared with P. B. M. City Stone "Halfway House;" the greatest plus discrepancy is 10.2 millimeters at P. B. M. $^{2}\frac{1}{2}^{A}$ and the greatest minus discrepancy is 40.1 millimeters at T. B. M. 102 Paige; it is a nail in the root of a tree. There are 18 bench marks that show discrepancies less than 10 millimeters; 33 show discrepancies greater than 10 millimeters and less than 20 millimeters; 8 show discrepancies greater than 20 millimeters and less than 30 millimeters; one discrepancy is −34.9 millimeters, and one is −40.1 millimeters. The discrepancy between the lines at P. B. M. $^{2}\frac{1}{2}^{2}$ at Fort St. Philip is + 0.7 millimeter.

The large discrepancy, 37.7 millimeters, between P. B. M's. $^{2}\frac{1}{2}^{2}$ and 10, at Fort Jackson, is no doubt due to the discrepancy between the two river crossings made at that point. The crossing in 1893 was made under bad conditions and the individual results show a wide range, which is probably due to large changes in refraction during the observations. The crossing, in 1898, was made under first-class conditions, and the individual results show a close agreement; hence we are justified in taking the results of 1898 as being the true difference of elevation.

From Fort Jackson to The Jump, 10 miles, we have 10 points for comparison; comparing these with P. B. M. 10, there are 6 that show a higher and 3 a lower elevation than that of 1893; the largest plus discrepancy is 11.7 millimeters at P. B. M. 8, and the largest minus discrepancy is 14.6 millimeters at B. M. A., which is on a brick chimney.

Below The Jump the discrepancies vary widely. Those bench marks situated on low ground subject to overflow for long periods show the largest minus discrepancies, which are either due to the general subsidence of these overflowed areas or to the settling into the mud of the bench marks themselves, or to both. Those bench marks situated on comparatively high ground, not subject to overflow, show the smallest discrepancies and they do not indicate subsidence.

P. B. M. 5 is on comparatively high ground above overflow, it having been filled in for an orange grove, and it does not show as large a minus discrepancy as the adjacent P. B. M.'s. P. B. M. J is on the light-house foundation at the end of the east jetty and indicates a very large settling of that structure. P. B. M. Fire is the most stable bench mark at the Head of Passes; the discrepancy between the two lines from P. B. M. City Stone "Halfway House" to this point, 101 miles, is −19.4 millimeters; or, leaving out the discrepancy of −37.7 millimeters due to the river crossing at Fort Jackson, it is +18.3 millimeters. P. B. M. I is the most stable bench mark at Port Eads; the discrepancy between the two lines at this point, 112 miles, is −40.8 millimeters; or, leaving out the discrepancy of −37.7 millimeters due to the river crossing at Fort Jackson, it is −3.1 millimeters.

TABULATION OF RESULTS.

In Tables Nos. 6, 7, 8, 9, and 10 the quantities given in the various columns are more fully explained as follows:

Column 1 gives the bench mark under consideration. The letters P. B. M. denote a permanent bench mark, and the letters T. B. M. denote a temporary bench mark, but in some cases it is quite permanent.

Column 2 gives the bench mark from which the bench mark in column 1 was determined.

Column 3 gives the distance in meters run between the bench marks in the two preceding columns.

Column 4 gives the total distance in kilometers of the bench mark under consideration from the initial point.

Column 5 gives the direction each line was run—direct indicating a line run from bench mark in column 2 to bench mark in column 1, reverse indicating a line run from bench mark in column 1 to bench mark in column 2.

Column 6 gives the difference in elevation in millimeters between the bench marks in columns 1 and 2 determined by each run, with its proper sign, and the mean of all these runs.

Column 7 gives the residuals for each result found by substracting each result from the mean result.

Columns 8 and 9 give the algebraic sum of the residuals, and show at every bench mark the amount that the two independent (direct and reverse) lines diverge from the mean.

Column 10 gives the probable error of each stretch, computed from the formula $r = \pm 0.6745\sqrt{\frac{\Sigma V^2}{m(m-1)}}$.

Column 11 gives the probable error of each bench mark when referred to the adopted mean gulf level at Biloxi Bay, computed by the formula $R = \pm\sqrt{\Sigma r^2}$.

Column 12 gives the elevation of the bench mark in column 1 in meters above the adopted mean gulf level.

Column 13 gives the elevation of the bench mark in column 1 in feet above the adopted mean gulf level.

Column 14 gives the former elevation of the bench mark in column 1 in meters, reduced to the adopted mean gulf level.

Column 15 gives the discrepancy in millimeters between the elevations given in columns 12 and 14. The plus sign indicates that the present elevation is higher than the former elevation, and the minus sign indicates that the present elevation is lower than the former elevation.

Column 16 gives the discrepancy shown in column 15, reduced to feet.

Column 17 gives the initial of the observer's surname: W denotes W. S. Williams, T denotes E. J. Thomas, and H denotes Eugene L. Harman.

Respectfully submitted.

W. S. WILLIAMS, *Surveyor.*

Capt. MASON M. PATRICK,
Corps of Engineers, U. S. A.

TABLE No. 5.—*Comparison of results obtained by the three lines of precise levels from Biloxi Bay to New Orleans.*

Bench mark.	Distance.	Elevation above mean gulf level.			Discrepancy.	
		M. R. C., 1882.	U. S. C. and G. S., 1886.	M. R. C., 1900.	1882 and 1900.	1886 and 1900.
	Km.	*Meters.*	*Meters.*	*Meters.*	*Mm.*	*Mm.*
[illegible] B. M. E	.....	.....	4.7914	4.7914	.....	0.0
[illegible] B. M. 19	2.212	1.7859	1.7907	1.7871	+ 1.2	− 3.6
[illegible] B. M. 17	10.608	7.8501	7.8567	7.8647	+14.6	+ 8.0
[illegible] B. M. 16	18.590	6.3607	6.3711	6.3605	− 0.2	−10.6
[illegible] B. M. 14	32.089	9.3833	9.4180	9.4072	+23.9	− 5.8
[illegible] B. M. 13	38.250	3.5838	3.3876	3.3693	+15.5	−18.3
[illegible] B. M. 11	46.745	6.4802	6.5819	6.5215	+41.3	−10.4
[illegible] B. M. 10	46.973	7.1312	7.1835	7.1732	+42.0	−10.3
[illegible] B. M. 9	53.730	4.6785	4.7263	4.7232	+44.7	− 3.1
[illegible] B. M. 8	59.226	2.9123	2.9649	2.9598	+47.5	− 5.1
[illegible] B. M. 7	67.987	1.2207	1.2709	1.2686	+47.9	− 2.3
[illegible] B. M. 6	70.344	3.1828	3.2342	3.1345	−48.3	−99.7
[illegible] B. M. 4	101.183	2.1606	2.2187	2.2233	+62.7	+ 4.6
[illegible] B. M. 3	131.187	1.2925	1.3505	1.3106	+18.1	−39.9
[illegible] B. M. 2	132.806	2.7772	2.8368	2.7982	+21.0	−38.6
[illegible] B. M. City Stone "Halfway House"	135.254	1.6049	.....	1.6391 (1898)	+34.2	.....
[illegible]ty B. M. XX Stone	140.091	1.3834	1.4391	1.4078 (1898)	+24.4	+31.3
[illegible]B. M. Carrollton	140.437	2.7657	2.8141	2.7338	−31.9	−80.3

TABLE No. 6.—*Tabulation of precise-level results to establish the relation between the Biloxi Bay staff gauge and the adjacent bench marks, 1898.*

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	U. S. C. and G. S., 1886.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. E_1, U. S. C. and G. S., 1886.											4.7914	15.720	4.7601	+31.3	+0.103	
B. M. "B"	P. B. M. E_1	1,021	1.021	Direct	−3,092.3	−0.25	−0.25	+0.25	0.17	0.2	1.6988	5.574				W.
				Reverse	−3,092.8	+ .25										
				Mean	−3,092.55											
12′ mark on Biloxi Bay staff gauge.	B. M. "B"	78		Direct	+ 104.8	− .25			.17	.2	1.8084	5.917				W.
				Reverse	+ 104.3	+ .25										
				Mean	+ 104.55											
B. M. "C"	B. M. "B"	69		Direct	−1,375.6	+ .20			.13	.3	.3284	1.061				W.
				Reverse	−1,375.2	− .20										
				Mean	−1,375.4											
B. M. "A"	B. M. "B"	126		Direct	+ 119.8	+ .10			.07	.3	1.8188	5.967				W.
				Reverse	+ 120.0	− .10										
				Mean	+ 119.9											
P. B. M. G_1=P. B. M., 20 M. R. C.	B. M. "B"	1,048	2.069	Direct	+ 415.8	+ .20	− .05	+ .05	.13	.3	2.1148	6.939	2.1012	+13.6	+ .045	W.
				Reverse	+ 416.2	− .20										
				Mean	+ 416.0											
P. B. M. H_1=P. B. M., 19 M. R. C.	P. B. M. G_1	146	2.215	Direct	− 330.2	+ .10	+ .05	− .05	.07	.3	1.7848	5.856	1.7594	+25.4	+ .083	W.
				Reverse	− 330.0	− .10										
				Mean	− 330.1											
P. B. M. 19 A (Williams 1898).	P. B. M. H_1	11		Direct	− 51.7	+ .20	+ .25	− .25	.13	.3	1.7832	5.687				W
				Reverse	− 51.3	− .20										
				Mean	− 51.5											

TABLE NO. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900.*

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation M. R. C.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. E_1, U. S C. and G. S., 1886.	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4.7914	15.720	.....	.....	.....	.....
P. B. M. Keenor, bolt in tile.	P. B. M. E_1.....	195	.195	Direct	+ 724.7	0.00	0.00	0.00	0.00	0.00	5.5161	18.098	.....	.....	.....	W.
				Reverse	+ 724.7	.00										
				Mean	+ 724.7											
Cap on P. B. M. Keenor.	P. B. M. E_1.....	195	.195	Direct	+1,938.2	− .25	− .25	+ .25	.17	.2	6.7294	22.078	.....	.....	.....	W.
				Reverse	+1,937.7	+ .25										
				Mean	+1,937.95											
B. M. "B".....	P. B. M. E_1.....	1,022	1.022	Direct	−3,092.2	−1.00	−1.00	+1.00	.67	.7	1.6982	5.572	1898. 1.6988	− 0.6	−0.002	W.
				Reverse	-3.094.2	+1.00										
				Mean	−3,093.2											
12′ mark on Biloxi Bay staff gauge.	B. M. "B".....	70	1.092	Direct	+ 100.3	+ .25	− .75	+ .75	.17	.7	1.7988	5.902	1898. 1.8084	− 4.6	− .015	W.
				Reverse	+ 100.8	− .25										
				Mean	+ 100.55											
P. B. M. 19 A (Williams 1898).	B. M. "B".....	1,190	2.212	Direct	+ 36.7	+ .75	− .25	+ .25	.50	.8	1.7356	5.694	1898. 1.7332	+ 2.4	+ .008	H.
				Reverse	+ 38.2	− .75					1898. 1.7332	5.687	1882. 1.7344	− 1.2	0.004	
				Mean	+ 37.45											
T. B. M. 185	P. B. M. 19A	1,516	1.516	Direct	+1,742.2	+ .90	+ .65	− .65	.60	.6	3.4763	.....	.....	.....	.....	H.
				Reverse	+1,744.0	− .90										
				Mean	+1,743.1											

TABLE No. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation M. R. C.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 184	T. B. M. 185	920	2.436	Direct	+1,884.2	+1.55	+2.20	−2.20	1.08	1.2	5.3620	17.592				H.
				Reverse	+1,887.3	−1.55										
				Mean	+1,885.75											
P. B. M., City Hall, Biloxi, Miss.	T. B. M. 184	323	2.759	Direct	+1,661.5	− .85	+1.35	−1.35	.57	1.3	7.0227	23.041				H.
				Reverse	+1,659.8	+ .85										
				Mean	+1,660.65											
T. B. M. 183	T. B. M. 184	553	2.989	Direct	+1,823.2	+ .25	+2.45	−2.45	.17	1.2	7.1855	23.575				H.
				Reverse	+1,823.7	− .25										
				Mean	+1,823.45											
T. B. M. 186	T. B. M. 183	73	3.062	Direct	+ 70.3	.00	+2.45	−2.45	.00	1.2	7.2558	23.805				W.
				Reverse	+ 70.3	.00										
				Mean	+ 70.3											
P. B. M., Hygeia; bolt in tile.	T. B. M. 183	92	3.081	Direct	− 677.8	+ .05	+2.50	−2.50	.08	1.2	6.5078	21.351				W.
				Reverse	− 677.7	− .05										
				Mean	− 677.75											
Cap on P. B. M., Hygeia.	T. B. M. 183	92	3.081	Direct	+ 535.5	+ .15	+2.60	−2.60	.10	1.2	7.7212	25.332				W.
				Reverse	+ 535.8	− .15										
				Mean	+ 535.65											
T. B. M. 182	T. B. M. 183	1,429	4.418	Direct	+ 260.0	+ .40	+2.85	−2.85	.27	1.2	7.4459					W.
				Reverse	+ 260.8	− .40										
				Mean	+ 260.4											
T. B. M. 181	T. B. M. 182	1,683	6.101	Direct	− 490.7	+ .75	+3.60	−3.60	.50	1.3	6.9560					W.
				Reverse	− 489.2	− .75										
				Mean	− 489.95											

T. B. M. 180	T. B. M. 181	993	7.094	Direct	+1,088.8	−1.05	+2.55	−2.55	.70	1.5	8.0437				W.
				Reverse	+1,086.7	+1.05									
				Mean	+1,087.75										
T. B. M. 179	T. B. M. 180	1,694	8.788	Direct	+ 691.2	+1.00	+3.55	−3.55	.67	1.6	8.7359				W.
				Reverse	+ 693.2	−1.00									
				Mean	+ 692.2										
P. B. M. 17	T. B. M. 179	1,820	10.608	Direct	− 871.7	+ .50	+4.05	−4.05	.38	1.7	7.8647	25.808	7.8501	+14.6	+0.048	H.
				Reverse	− 870.7	− .50									
				Mean	− 871.2										
T. B. M. 178	P. B. M. 17	764	11.372	Direct	+ 253.3	−1.25	+2.80	−2.80	.83	1.9	8.1168					H.
				Reverse	+ 250.8	+1.25									
				Mean	+ 252.05										
T. B. M. 177	T. B. M. 178	1,282	12.604	Direct	− 383.3	+ .05	+2.85	−2.85	.08	1.9	7.7335					H.
				Reverse	− 383.2	− .05									
				Mean	− 383.25										
T. B. M. 176	T. B. M. 177	1,866	14.470	Direct	− 546.0	−1.25	+1.60	−1.60	.88	2.0	7.1862					H.
				Reverse	− 548.5	+1.25									
				Mean	− 547.25										
T. B. M. 175	T. B. M. 176	2,132	16,602	Direct	+ 117.8	− .50	+1.10	−1.10	.33	2.1	7.3086					W.
				Reverse	+ 116.8	+ .50									
				Mean	+ 117.3										
T. B. M. 174	T. B. M. 175	1,685	18,287	Direct	−1,363.0	+1.60	+2.70	−2.70	1.07	2.3	5.9422					W.
				Reverse	−1,359.8	−1.60									
				Mean	−1,361.4										
P. B. M. 16, Mississippi City.	T. B. M. 174	243	18.530	Direct	+ 418.1	+ .25	+2.95	−2.95	.17	2.3	6.3605	20.868	6.3607	− .2	− .001	H
				Reverse	+ 418.6	− .25									
				Mean	+ 418.35										
T. B. M. 173	T. B. M. 174	1,557	19.844	Direct	+ 405.8	−1.15	+1.55	−1.55	.77	2.5	6.3468					H.
				Reverse	+ 403.5	+1.15									
				Mean	+ 404.65										

TABLE No. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation M. R. C.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 172	T. B. M. 173	911	20.755	Direct	+ 832.5	−0.75	+0.80	−0.80	0.50	2.5	7.1786					H.
				Reverse	+ 831.0	+ .75										
				Mean	+ 831.75											
T. B. M. 171	T. B. M. 172	806	21.561	Direct	− 313.0	− .97	− .17	+ .17	.84	2.6	6.8646					H.
				First reverse	− 316.4	+2.43										
				Second reverse	− 312.5	−1.47										
				Mean	− 313.97											
T. B. M. 170	T. B. M. 171	1,017	22.578	Direct	+ 272.2	+ .30	+ .13	− .13	.20	2.7	7.1871					H.
				Reverse	+ 272.8	− .30										
				Mean	+ 272.5											
T. B. M. 169	T. B. M. 170	1,497	24.075	Direct	+ 480.2	−1.45	−1.82	+1.82	.97	2.8	7.6158					W.
				Reverse	+ 477.3	+1.45										
				Mean	+ 478.75											
T. B. M. 168	T. B. M. 169	1,750	25.825	Direct	+ 290.2	− .60	−1.92	+1.92	.40	2.9	7.9054					W.
				Reverse	+ 289.0	+ .60										
				Mean	+ 289.6											
T. B. M. 167	T. B. M. 168	1,145	26.970	Direct	− 202.0	− .90	−2.82	+2.82	.60	2.9	7.7025					W.
				Reverse	− 203.8	+ .90										
				Mean	− 202.9											
T. B. M. 166	T. B. M. 167	1,040	28.010	Direct	+ 330.8	+ .75	−2.07	+2.07	.50	3.0	8.0341					W.
				Reverse	+ 332.3	− .75										
				Mean	+ 331.55											

T. B. M. 165	T. B. M. 166	989	28.949	Direct Reverse	+ 656.8 + 654.3	−1.25 +1.25	−3.82	+3.82	.83	3.1	8.6896					H.
				Mean	+ 655.55											
T. B. M. 164	T. B. M. 165	884	29.833	Direct Reverse	− 223.2 − 226.2	−1.50 +1.50	−4.82	+4.82	1.00	3.2	8.4649					H.
				Mean	− 224.7											
T. B. M. 168	T. B. M. 164	833	30.666	Direct Reverse	+ 177.8 + 180.3	+1.50 −1.50	−3.32	+3.32	1.00	3.4	8.6437					W.
				Mean	+ 178.8											
P. B. M. 14	T. B. M. 163	1,423	32.089	Direct Reverse	+ 763.8 + 763.2	− .30 + .30	−3.62	+3.62	.20	3.4	9.4072	30.864	9.3833	+23.9	+0.078	W.
				Mean	+ 763.5											
T. B. M. 162	P. B. M. 14	928	33.017	Direct Reverse	− 97.0 − 94.0	+1.50 −1.50	−2.12	+2.12	1.00	3.5	9.3117					W.
				Mean	− 95.5											
T. B. M. 161	T. B. M. 162	1,740	34.757	Direct Reverse	−2,810.7 −2,810.3	+ .20 − .20	−1.92	+1.92	.13	3.5	6.5012					W.
				Mean	−2,810.5											
T. B. M. 160	T. B. M. 161	1,076	35.833	Direct Reverse	− 943.3 − 941.0	+1.15 −1.15	− .77	+ .77	.77	3.6	5.5591					H.
				Mean	− 942.15											
T. B. M. 159	T. B. M. 160	1,684	37.517	Direct Reverse	−2,440.3 −2,441.0	− .35 + .35	−1.12	+1.12	.23	3.6	3.1184					H.
				Mean	−2,440.65											
P. B. M. 13; Pass Christian.	T. B. M. 159	733	38.250	Direct Reverse	+ 251.0 + 250.7	− .15 + .15	−1.27	+1.27	.10	3.6	3.3693	11.054	3.3538	+15.5	+ .051	H.
				Mean	+ 250.85											
T. B. M. 158	P. B. M. 13	698	38.948	Direct Reverse	− 309.0 − 308.8	+ .10 − .10	−1.17	+1.17	.07	3.6	3.0604					H.
				Mean	− 308.9											

TABLE No. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation M. R. C.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 157	T. B. M. 158	1,861	40.809	Direct	− 141.5	−0.15	−1.32	+1.32	0.10	3.6	2.9187					H.
				Reverse	− 141.8	+ .15										
				Mean	− 141.65											
T. B. M. 156	T. B. M. 157	2,171	42.980	Direct	− 958.8	+ .30	−1.02	+1.02	.20	3.6	1.9602					W.
				Reverse	− 958.2	− .30										
				Mean	− 958.5											
T. B. M. 155	T. B. M. 156	1,274	44.254	Direct	− 20.3	−1.10	−2.12	+2.12	.73	3.7	1.9388					W.
				Reverse	− 22.5	+1.10										
				Mean	− 21.4											
P. B. M. 11; Bay St. Louis.	T. B. M. 155	2,491	46.745	Direct	+4,581.7	+1.00	−1.12	+1.12	.67	3.8	6.5215	21.396	6.4802	+41.3	+0.135	W.
				Reverse	+4,583.7	−1.00										
				Mean	+4,582.7											
P. B. M. 10	P. B. M. 11	228	46.973	Direct	+ 651.4	+ .25	− .87	+ .87	.17	3.8	7.1732	23.534	7.1312	+42.0	+ .138	W.
				Reverse	+ 651.9	− .25										
				Mean	+ 651.65											
T. B. M. 154	P. B. M. 11	866	47.611	Direct	+ 941.8	− .50	−1.62	+1.62	.33	3.8	7.4628					W.
				Reverse	+ 940.8	+ .50										
				Mean	+ 941.3											
T. B. M. 153	T. B. M. 154	1,779	49.390	Direct	− 186.5	−2.40	−4.02	+4.02	1.60	4.1	7.2739					H.
				Reverse	− 191.3	+2.40										
				Mean	− 188.9											

T. B. M. 152	T. B. M. 153	1,906	51.356	Direct	2,166.3	−1.20	−5.22	+5.22	.80	4.2	5.1064					W.
				Reverse	−2,168.7	+1.20										
				Mean	−2,167.5											
P. B. M. 9	T. B. M. 152	2,374	53.730	Direct	− 382.8	− .45	−5.67	+5.67	.80	4.2	4.7232	15.496	4.6785	+44.7	+ .147	W.
				Reverse	− 383.7	+ .45										
				Mean	− 383.25											
T. B. M. 151	P. B. M. 9	1,222	54.952	Direct	−1,612.3	− .70	−6.37	+6.37	.47	4.2	3.1102					W.
				Reverse	−1,613.7	+ .70										
				Mean	−1,613.0											
T. B. M. 150	T. B. M. 151	810	55.762	Direct	− 241.5	+ .15	−6.22	+6.22	.10	4.2	2.8688					H.
				Reverse	− 241.2	− .15										
				Mean	− 241.35											
T. B. M. 149	T. B. M. 150	1,604	57.366	Direct	− 14.5	+ .75	−5.47	+5.47	.50	4.2	2.8551					H
				Reverse	− 13.0	− .75										
				Mean	− 13.75											
T. B. M. 148	T. B. M. 149	822	58.188	1st direct	− 567.0	−1.93	−8.34	+8.34	.99	4.4	2.2900					H.
				Reverse	− 562.2	+2.87										
				2d direct	− 566.0	− .93										
				Mean	− 565.07											
T. B. M. 147	T. B. M. 148	503	58.691	Direct	−1,101.3	+ .50	−7.84	+7.84	.33	4.4	1.1892					H.
				Reverse	−1,100.3	− .50										
				Mean	−1,100.8											
P. B. M. 8	T. B. M. 147	535	59.226	Direct	+1,770.8	− .25	−8.09	+8.09	.17	4.4	2.9598	9.711	2.9123	+47.5	+.156	H.
				Reverse	+1,770.3	+ .25										
				Mean	+1,770.55											
T. B. M. 146	P. B. M. 8	1,319	60.545	Direct	-1,066.7	+1.00	+7.09	+7.09	.67	4.4	1.8941					H.
				Reverse	-1,064.7	−1.00										
				Mean	- 1,065.7											
T. B. M. 145	T. B. M. 146	825	61.370	Direct	+ 57.2	+ .55	−6.54	+6.54	.37	4.4	1.9518					H.
				Reverse	+ 58.3	− .55										
				Mean	+ 57.75											

TABLE No. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation M. R. C.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 144	T. B. M. 145	805	62.175	First direct	− 763.0	−0.12	−7.17	+7.17	1.34	4.6	1.1887					H.
				First reverse	− 759.0	−4.12										
				Second direct	− 762.0	−1.12										
				Second reverse	− 768.5	+5.38										
				Mean	− 763.12											
T. B. M. 143	T. B. M. 144	1,586	63.761	Direct	+ 680.2	− .60	−7.77	+7.77	.40	4.7	1.8683					W.
				Reverse	+ 679.0	+ .60										
				Mean	+ 679.6											
T. B. M. 142	T. B. M. 143	1,637	65.398	Direct	− 818.2	+ .10	−7.67	+7.67	.07	4.7	1.5502					W.
				Reverse	− 818.0	− .10										
				Mean	− 818.1											
P. B. M. 7	T. B. M. 142	2,539	67.937	Direct	− 281.3	− .25	−7.92	+7.92	.17	4.7	1.2686	4.162	1.2207	+47.9	+0.157	W.
				Reverse	− 281.8	+ .25										
				Mean	− 281.55											
T. B. M. 141	P. B. M. 7	1,565	69.502	Direct	+ 286.0	−1.60	−9.52	+9.52	1.07	4.8	1.5580					W.
				Reverse	+ 282.8	+1.60										
				Mean	+ 284.40											
P. B. M. 6: Pearl River.	T. B. M. 141	842	70.344	Direct	+1,581.2	+ .30	−9.22	+9.22	.20	4.8	3.1345	10.284	3.1828	−48.3	− .158	W.
				Reverse	+1,581.8	− .30										
				Mean	+1,581.5											
T. B. M. 140	P. B. M. 6	1,407	71.751	Direct	−1,469.2	+ .45	−8.77	+8.77	.80	4.8	1.6658					H.
				Reverse	−1,468.3	− .45										
				Mean	−1,468.75											

T. B. M. 139; Lookout.	T. B. M. 140.....	1,658	78.409	Direct.....	+ 117.5	+1.85	0.92	+0.92	1.23	5.0	1.7851	.....	.....	.....	.....	H.
				Reverse.....	+ 121.2	−1.85										
				Mean....	+ 119.35											
T. B. M. 138.....	T. B. M. 139.....	1,187	74.596	Direct.....	+ 299.3	+1.95	−4.97	+4.97	1.30	5.1	2.0864	.....	.....	.....	.....	H.
				Reverse.....	+ 303.2	−1.95										
				Mean....	+ 301.25											
T. B. M. 137.....	T. B. M. 138.....	1,839	75.985	Direct.....	− 338.7	+ .60	−4.37	+4.37	.40	5.1	1.7483	.....	.....	.....	.....	H.
				Reverse.....	− 337.5	− .60										
				Mean....	− 338.1											
T. B. M. 136.....	T. B. M. 137.....	1,784	77.669	Direct.....	− 48.8	+ .65	−3.72	+3.72	.43	5.2	1.7001	.....	.....	.....	.....	H.
				Reverse.....	− 47.5	− .65										
				Mean....	− 48.15											
T. B. M. 135.....	T. B. M. 136.....	1,602	79.271	Direct.....	− 76.8	0.00	-3.72	+3.72	.00	5.2	1.6233	.....	.....	.....	.....	H.
				Reverse.....	− 76.8	0.00										
				Mean....	− 76.8											
T. B. M. 134.....	T. B. M. 135.....	1,311	80.582	Direct.....	+ 786.3	− .40	−4.12	+4.12	.27	5.2	2.4092	.....	.....	.....	.....	W.
				Reverse.....	+ 785.5	+ .40										
				Mean....	+ 785.9											
T. B. M. 133; Rigolets.	T. B. M. 134.....	858	81.440	Direct.....	+ 504.8	+ .70	−3.42	+3.42	.47	5.2	2.9147	.....	.....	.....	.....	W.
				Reverse.....	+ 506.2	− .70										
				Mean....	+ 505.5											
T. B. M. 132.....	T. B. M. 133.....	777	82.217	Direct.....	− 979.2	+1.25	−2.17	+2.17	.83	5.2	1.9368	.....	.....	.....	.....	W.
				Reverse.....	− 976.7	−1.25										
				Mean....	− 977.95											
T. B. M. 131.....	T. B. M. 132.....	941	83.158	Direct.....	− 169.8	− .20	−2.37	+2.37	.18	5.2	1.7668	.....	.....	.....	.....	W.
				Reverse.....	− 170.2	+ .20										
				Mean....	− 170.0											
T. B. M. 130.....	T. B. M. 131.....	910	84.068	Direct.....	− 89.7	−1.00	−3.37	+3.37	.67	5.3	1.6761	.....	.....	.....	.....	H.
				Reverse.....	− 91.7	+1.00										
				Mean....	− 90.7											

TABLE No. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals—V.	ΣV. Direct line.	ΣV. Reverse line.	r±.	R±.	Elevation above mean Gulf level. 1900.	1900.	Former elevation M. R. C.	Discrepancy.		Observer.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 129	T. B. M. 130	1,611	85.679	Direct	− 26.0	+0.35	−3.02	+3.02	0.23	5.3	1.6504					W.
				Reverse	− 25.3	− .35										
				Mean	− 25.65											
T. B. M. 128	T. B. M. 129	707	86.386	Direct	+ 135.0	− .40	−3.42	+3.42	.27	5.3	1.7850					W.
				Reverse	+ 134.2	+ .40										
				Mean	+ 134.6											
T. B. M. 127	T. B. M. 128	1,633	88.019	Direct	− 932.0	+ .65	−2.77	+2.77	.43	5.3	.8587					W.
				Reverse	− 930.7	− .65										
				Mean	− 931.35											
T. B. M. 126	T. B. M. 127	610	88.629	First direct	+ 731.7	+2.03	- .81	+ .81	.78	5.4	1.5874					H.
				Reverse	+ 735.7	−1.97										
				Second direct	+ 733.8	− .07										
				Mean	+ 733.73											
T. B. M. 125	T. B. M. 126	577	89.206	Direct	− 4.3	+ .80	− .01	+ .01	.58	5.4	1.5889					H.
				Reverse	− 2.7	− .80										
				Mean	− 3.5											
T. B. M. 124, Lake Catherine.	T. B. M. 125	1,267	90.473	Direct	+ 18.7	+1.75	+1.74	−1.74	1.17	5.5	1.6044					H.
				Reverse	+ 22.2	−1.75										
				Mean	+ 20.45											
T. B M. 123	T. B. M. 124	1,600	92.073	Direct	− 878.8	−1.20	+ .54	− .54	.80	5.6	1.2244					H.
				Reverse	− 881.2	+1.20										
				Mean	− 880.0											

T. B. M. 123	T. B. M. 123	1,475	93.548	Direct	+ 355.0	− .25	+ .29	− .29	.17	5.6	1.5791				W.
				Reverse	+ 354.5	+ .25									
				Mean	+ 354.75										
T. B. M. 121	T. B. M. 122	1,652	95.200	Direct	− 196.7	− .25	+ .04	− .04	.17	5.6	1.3822				W
				Reverse	− 197.2	+ .25									
				Mean	− 196.95										
T. B. M. 120	T. B. M. 121	2,731	97.931	Direct	− 92.0	+ .25	+ .29	− .29	.17	5.6	1.2904				W.
				Reverse	− 91.5	− .25									
				Mean	− 91.75										
T. B. M. 119	T. B. M. 120	1,175	99.106	Direct	+ 340.2	− .50	− .21	+ .21	.33	5.6	1.6801				H.
				Reverse	+ 339.2	+ .50									
				Mean	+ 339.7										
T. B. M. 118	T. B. M. 119	1,571	100.677	Direct	+ 788.5	− .40	− .61	+ .61	.27	5.6	2.4182				H.
				Reverse	+ 787.7	+ .40									
				Mean	+ 788.1										
P. B. M. 4, Chef Menteur.	T. B. M. 118	506	101.183	Direct	− 195.2	+ .30	− .31	+ .31	.20	5.6	2.2283	7.294	2.1606	+62.7	+0.206 H.
				Reverse	− 194.6	− .30									
				Mean	− 194.9										
T. B. M. 117	T. B. M. 118	567	101.244	Direct	− 723.2	− .90	−1.51	+1.51	.60	5.6	1.6941				H.
				Reverse	− 725.0	+ .90									
				Mean	− 724.1										
T. B. M. 116	T. B. M. 117	1,452	102.696	Direct	− 133.3	−1.35	−2.86	+2.86	.90	5.7	1.5595				H.
				Reverse	− 136.0	+1.35									
				Mean	− 134.65										
T. B. M. 115	T. B. M. 116	1,534	104.230	Direct	+ 4.8	+ .10	−2.76	+2.76	.07	5.7	1.5644				H.
				Reverse	+ 5.0	− .10									
				Mean	+ 4.9										
T. B. M. 114	T. B. M. 115	1,744	105,974	Direct	− 537.0	−1.60	−4.36	+4.36	1.07	5.8	1.0258				W.
				Reverse	− 540.2	+1.60									
				Mean	− 538.6										

TABLE No. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation M. R. C.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 113	T. B. M. 114	1,466	107.440	Direct	+ 107.8	−1.90	−6.26	+6.26	1.27	6.0	1.1317					W.
				Reverse	+ 104.0	+1.90										
				Mean	+ 105.9											
T. B. M. 112	T. B. M. 113	1,647	109.087	Direct	+ 419.3	+ .10	−6.16	+6.16	.07	6.0	1.5511					W.
				Reverse	+ 419.5	− .10										
				Mean	+ 419.4											
T. B. M. 111	T. B. M. 112	902	109.989	Direct	− 575.5	+ .15	−6.01	+6.01	.10	6.0	.9757					W.
				Reverse	− 575.2	− .15										
				Mean	− 575.35											
T. B. M. 110	T. B. M. 111	1,381	111.370	Direct	+ 527.5	− .90	−6.91	+6.91	.60	6.0	1.5023					W.
				Reverse	+ 525.7	+ .90										
				Mean	+ 526.6											
T. B. M. 109	T. B. M. 110	1,763	113.133	Direct	− 367.8	+ .55	−6.36	+6.36	.37	6.0	1.1351					W.
				Reverse	− 366.7	− .55										
				Mean	− 367.25											
T. B. M. 108	T. B. M. 109	1,625	114.758	Direct	+ 393.8	+ .75	−5.61	+5.61	.50	6.0	1.5296					W.
				Reverse	+ 395.3	− .75										
				Mean	+ 394.55											
T. B. M. 107	T. B. M. 108	739	115.497	Direct	−1,074.5	+ .15	−5.46	+5.46	.10	6.0	.4558					W.
				Reverse	−1,074.2	− .15										
				Mean	−1,074.35											

T. B. M. 106	T. B. M. 107	1,027	116.534	Direct	+ 597.5	+1.40	−4.06	+4.06	.98	6.1	1.0642				H.
				Reverse	+ 600.8	−1.40									
				Mean	+ 598.9										
T. B. M. 105	T. B. M. 106	1,336	117.860	Direct	− 424.3	−1.70	−5.76	+5.76	1.13	6.2	.6282				H.
				Reverse	− 427.7	+1.70									
				Mean	− 426.0										
T. B. M. 104	T. B. M. 105	811	118.671	Direct	+ 16.8	+ .75	−5.01	+5.01	.50	6.2	.6457				H.
				Reverse	+ 18.3	− .75									
				Mean	+ 17.55										
T. B. M. 103	T. B. M. 104	826	119.497	Direct	+ 185.2	+2.13	−2.88	+2.88	.80	6.3	.8330				H.
				First reverse	+ 189.3	−1.97									
				Second reverse	+ 187.5	− .17									
				Mean	+ 187.33										
T. B. M. 102	T. B. M. 103	903	120.400	Direct	+ 451.7	+1.40	−1.48	+1.48	.93	6.3	1.2862				H.
				Reverse	+ 454.5	−1.40									
				Mean	+ 453.1										
T. B. M. 101	T. B. M. 102	1,412	121,812	Direct	− 26.2	+1.85	+ .37	− .37	1.23	6.4	1.2618				W.
				Reverse	− 22.5	−1.85									
				Mean	− 24.35										
T. B. M. 100	T. B. M. 101	1,970	123.782	Direct	− 140.7	+1.50	+1.87	−1.87	1.00	6.5	1.1226				W.
				Reverse	− 137.7	−1.50									
				Mean	− 139.2										
T. B. M. 99	T. B. M. 100	778	124.560	Direct	+ 130.0	+1.60	+3.47	−3.47	1.07	6.6	1.2542				W.
				Reverse	+ 133.2	−1.60									
				Mean	+ 131.6										
T. B. M. 98	T. B. M. 99	1,496	126.056	Direct	− 807.3	+2.00	+5.47	−5.47	1.33	6.7	.4489				W.
				Reverse	− 803.3	−2.00									
				Mean	− 805.3										
T. B. M. 97	T. B. M. 98	906	126.962	Direct	+ 563.3	+1.00	+6.47	−6.47	.67	6.8	1.0132				H.
				Reverse	+ 565.3	−1.00									
				Mean	+ 564.3										

TABLE No. 7.—*Tabulation of precise-level results from Biloxi, Miss., to New Orleans, La., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation M. R. C.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 96	T. B. M. 97	686	127.648	First direct	− 17.3	+2.95	+8.77	−8.77	0.98	6.8	0.9988					H.
				First reverse	− 13.3	−1.05										
				Second direct	− 16.0	+1.65										
				Second reverse	− 10.8	−3.55										
				Mean	− 14.35											
T. B. M. 95	T. B. M. 96	771	128.419	Direct	+ 163.0	+ .75	+9.52	−9.52	.50	6.9	1.1626					H.
				Reverse	+ 164.5	− .75										
				Mean	+ 163.75											
P. B. M. 41	T. B. M. 95	645	129.064	Direct	− 990.2	+ .25	+9.77	−9.77	.17	6.9	.1726	0.566	(1898) 0.1460	+26.8	+0.088	H.
				Reverse	− 989.7	− .25										
				Mean	− 989.95											
T. B. M 170 (Paige 1898).	P. B. M. 41	1,106	130,170	Direct	+ 94.3	−1.80	+7.97	−7.97	1.20	7.0	2652		(1898) .2845	+30.7	+ .101	H.
				Reverse	+ 90.7	+1.80										
				Mean	+ 92.5											
T. B. M. 94	T. B. M. 170 (Paige 1898).	948	131.118	Direct	+ 601.0	+ .75	+8.72	−8.72	.50	7.0	.8669					H.
				Reverse	+ 602.5	− .75										
				Mean	+ 601.75											
P. B. M. 3	T. B. M. 94	69	131.187	Direct	+ 443.2	+ .45	+9.17	−9.17	.30	7.0	1.3106	4.300	(1882) 1.2925	+18.1	+ .059	H.
				Reverse	+ 444.1	− .45										
				Mean	+ 443.65											
T. B. M. 175 (Paige 1898).	T. B. M. 94	362	131.480	Direct	− 220.8	− .50	+8.22	−8.22	.33	7.0	.6456	2.118	(1898) .6143	+31.3	+ .103	W.
				Reverse	− 221.8	+ .50										
				Mean	− 221.3											

T. B. M. 93	T. B. M. 175 (Paige 1893).	1,803	132.783	Direct	− 263.8	+ .90	+9.12	−9.12	.60	7.0	.3827				W.
				Reverse	− 262.0	− .90									
				Mean	− 262.9										
P. B. M. 2	T. B. M. 93	23	132.806	Direct	+2,415.5	.00	+9.12	−9.12	.00	7.0	2.7982	9.181	(1882) 2.7772	+21.0	+ .069	W.
				Reverse	+2,415.5	.00									
				Mean	+2,415.5										
T. B. M. 92	T. B. M. 93	518	133.601	Direct	+1,187.3	−1.00	+8.12	−8.12	.67	7.1	1.5690				W.
				Reverse	+1,185.3	+1.00									
				Mean	+1,186.3										
P. B. M. City Stone, "Halfway House."	T. B. M. 92	1,653	135.254	Direct	+ 69.0	+1.15	+9.27	−9.27	.77	7.1	1.6391	5.878	(1882) 1.6049	+34.2	+ .112	W.
				Reverse	+ 71.3	−1.15									
				Mean	+ 70.15										

NOTE.—Probable error for kilometer=0.61 millimeter. Except where otherwise specified, the "former elevation" used is that of 1882.

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898.*

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. City Stone, "Halfway House."										7.1	1.6891	5.878	1.6049	+34.2	+0.112	
T. B. M. 155	P. B. M. City Stone, "Halfway House."	29	0.029	Direct Reverse Mean	+ 456.7 + 456.7 + 456.7	0.00 .00	0.00	0.00	0.00	7.1	2.0958					T.
T. B. M. 156	T. B. M. 155	578	.602	1 direct 1 reverse 2 direct 2 reverse Mean	−1,343.3 −1,340.0 −1,342.7 −1,342.3 −1,342.08	+1.22 −2.08 + .62 + .22	+ .92	− .92	.58	7.1	.7588					T.
T. B. M. 157	T. B. M. 156	583	1.185	Direct Reverse Mean	+ 827.3 + 830.3 + 828.8	+1.50 −1.50	+2.42	−2.42	1.00	7.2	1.5826					T.
City Stone XXMR	T. B. M. 157	30	1.215	Direct Reverse Mean	− 111.0 − 111.0 − 111.0	.00 .00	+2.42	−2.42	.00	7.2	1.4716	4.828				T.
P. B. M. City Park	City Stone, XXMR.	92	1.307	Direct Reverse Mean	+ 3.0 + 3.3 + 3.15	+ .15 − .15	+2.57	−2.57	.10	7.2	1.4747	4.838				T.
T. B. M. 158	T. B. M. 157	1,210	2.395	Direct Reverse Mean	− 311.3 − 307.7 − 309.5	+1.80 −1.80	+4.22	−4.22	1.20	7.3	1.2781					T.
P. B. M. 2	T. B. M. 158	25	2.420	Direct Reverse Mean	+1,524.0 +1,524.6 +1,524.3	+ .30 − .30	+4.52	−4.52	.20	7.3	2.7974	9.178	2.7765	+20.9	+ .069	T.

T. B. M. 175 (Paige, 1893).	T. B. M. 168.....	1,308	8.708	Direct.....	− 627.7	+1.05	+5.27	−5.27	.70	7.8	.6464	2.120	.6145	+32.1	+ .105	T.
				Reverse.....	− 625.6	−1.05										
				Mean....	− 626.65											
T. B. M. 161	T. B. M. 175 (Paige, 1893).	356	4.059	Direct.....	+ 348.3	+ .85	+6.12	−6.12	.57	7.3	.9956	.....	.....	.....	.....	T.
				Reverse.....	+ 350.0	− .85										
				Mean....	+ 349.15											
P. B. M. 3	T. B. M. 161.....	40	4.099	Direct.....	+ 316.0	+ .35	+6.47	−6.47	.23	7.3	1.3119	4.304	1.2837	+28.2	+ .093	T.
				Reverse.....	+ 316.7	− .35										
				Mean....	+ 316.35											
P. B. M. 41	T. B. M. 161.....	1,942	6.001	Direct.....	− 819.3	+ .50	+6.62	−6.62	.38	7.4	.1768	.580	.1460	+30.8	+ .101	T.
				Reverse.....	− 818.3	− .50										
				Mean....	− 818.8											
T. B. M. 162	P. B. M. 41.....	1,184	7.185	Direct.....	+ 848.0	− .40	+6.22	−6.22	.27	7.4	1.0244	.....	.....	.....	.....	W.
				Reverse.....	+ 847.2	+ .40										
				Mean....	+ 847.6											
P. B. M. 40	T. B. M. 162.....	16	7.201	Direct.....	+1,251.5	+ .20	+6.42	−6.42	.13	7.4	2.2761	7.467	2.2474	+28.7	+ .094	W.
				Reverse.....	+1,251.9	− .20										
				Mean....	+1,251.7											
T. B. M. 163	T. B. M. 162.....	865	8.050	Direct.....	+ 466.3	+ .70	+6.92	−6.92	.47	7.4	1.4914	.....	.....	.....	.....	W.
				Reverse.....	+ 467.7	− .70										
				Mean....	+ 467.0											
T. B. M. 164	T. B. M. 163a....	808	8.853	Direct.....	− 265.3	+1.75	+ 8.67	− 8.67	1.17	7.5	1.2278	.....	.....	.....	.....	W.
				Reverse.....	− 261.8	−1.75										
				Mean....	− 263.55											
P. B. M. 39	T. B. M. 164.....	80	8.933	Direct.....	+ 208.6	− .05	+ 8.62	− 8.62	.08	7.5	1.4314	4.696	1.4041	+27.3	+ .089	W.
				Reverse.....	+ 208.5	+ .05										
				Mean....	+ 208.55											
T. B. M. 165	T. B. M. 164.....	762	9.615	Direct.....	− 151.7	+ .75	+ 9.42	− 9.42	.50	7.5	1.0769	.....	.....	.....	.....	W.
				Reverse.....	− 150.2	− .75										
				Mean....	− 150.95											

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 166	T. B. M. 165	984	10.599	Direct	+ 1.0	+1.50	+10.92	−10.92	1.00	7.5	1.0794					W.
				Reverse	+ 4.0	−1.50										
				Mean	+ 2.5											
T. B. M. 168	T. B. M. 166	183	10.782	Direct	− 96.7	+ .50	+11.42	−11.42	.33	7.6	.9832					T.
				Reverse	− 95.7	− .50										
				Mean	− 96.2											
P. B. M. $^{2}/_{3}^{8}$	T. B. M. 168	154	10.936	Direct	− 847.7	.00	+11.42	−11.42	.00	7.6	.1355	0.444	*a*.1168	+18.7	+0.061	T.
				Reverse	− 847.7	.00										
				Mean	− 847.7											
P. B. M. $^{2}/_{3}^{8}$ A	T. B. M. 168	154	10.936	Direct	+ 351.3	.00	+11.42	−11.42	.00	7.6	1.3345	4.378	1.3182	+16.3	+ .058	T.
				Reverse	+ 351.3	.00										
				Mean	+ 351.3											
T. B. M. 167	T. B. M. 166	1,632	12.231	Direct	+ 65.7	−1.00	+ 9.92	− 9.92	.67	7.6	1.1441					T.
				Reverse	+ 63.7	+1.00										
				Mean	+ 64.7											
P. B. M. 38	T. B. M. 167	775	13.006	Direct	+2,017.7	+ .80	+10.72	−10.72	.53	7.6	3.1626	10.376	3.1373	+25.3	+ .083	T.
				Reverse	+2,019.3	− .80										
				Mean	+2,018.5											
T. B. M. 169	P. B. M. 38	1,175	14.181	Direct	− 255.3	−2.20	+ 8.52	− 8.52	1.47	7.7	2.9051					T.
				Reverse	− 259.7	+2.20										
				Mean	− 257.5											
T. B. M. 170	T. B. M. 169	1,357	15.538	Direct	− 54.3	+1.05	+ 9.57	− 9.57	.70	7.8	2.8518	9.3564				W.
				Reverse	− 52.2	−1.05										
				Mean	− 53.25											

T. B. M. 171	T. B. M. 170	906	16.444	Direct	+ 404.0	+1.40	+10.97	−10.97	.98	7.8	3.2572				W.
				Reverse	+ 406.8	−1.40									
				Mean	+ 406.4										
P. B. M. 21ª	T. B. M. 171	802	16.746	Direct	−1,201.2	+ .25	+11.22	−11.22	.17	7.8	2.0663	6.746	2.0819	+24.4	+ .060	W.
				Reverse	−1,200.7	− .25									
				Mean	−1,200.95										
T. B. M. 172	T. B. M. 171	1,459	17.908	Direct	− 2.7	+ .10	+11.07	−11.07	.07	7.8	3.2546				W.
				Reverse	− 2.5	− .10									
				Mean	− 2.6										
T. B. M. 173	T. B. M. 172	978	18.881	Direct	− 453.3	− .55	+10.52	−10.52	.37	7.8	2.8008				T.
				Reverse	− 454.4	+ .55									
				Mean	− 453.85										
P. B. M. 37	T. B. M. 173	104	18.985	Direct	− 599.0	+ .15	+10.67	−10.67	.10	7.8	2.2019	7.224	2.2026	− .7	− .002	T.
				Reverse	− 598.7	− .15									
				Mean	− 598.85										
P. B. M. 37 A	T. B. M. 173	104	18.985	Direct	+ 600.3	+ .20	+10.72	−10.72	.13	7.8	3.4013	11.159	3.4020	− .7	− .002	T.
				Reverse	+ 600.7	− .20									
				Mean	+ 600.5										
T. B. M. 173 A	T. B. M. 173	769	19.650	Direct	+ 644.7	−1.20	+ 9.32	− 9.32	.80	7.9	3.4443				T.
				Reverse	+ 642.3	+1.20									
				Mean	+ 643.5										
T. B. M. 174	T. B. M. 173 A	754	20.404	Direct	−1,294.3	−1.20	+ 8.12	− 8.12	.80	7.9	2.1488				T.
				Reverse	−1,296.7	+1.20									
				Mean	−1,295.5										
T. B. M. 175	T. B. M. 174	1,786	22.190	Direct	+ 97.7	− .35	+ 7.77	− 7.77	.23	7.9	2.2461				T.
				Reverse	+ 97.0	+ .35									
				Mean	+ 97.35										
T. B. M. 176	T. B. M. 175	1,498	23.683	Direct	+ 525.7	+ .55	+ 8.32	− 8.32	.37	7.9	2.7724				W.
				Reverse	+ 526.8	− .55									
				Mean	+ 526.25										

a Ordinary levels.

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V. Direct line.	Σ V. Reverse line.	r±.	R±.	Elevation above mean Gulf level. 1898.	1898.	M. R. C. 1893.	Discrepancy.		Observer.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 177	T. B. M. 176	768	24.451	Direct	+ 6.7	−0.10	+ 8.22	− 8.22	0.07	7.9	2.7790					W.
				Reverse	+ 6.5	+ .10										
				Mean	+ 6.6											
P. B. M. 36	T. B. M. 177	308	24.759	Direct	−1,686.2	− .50	+ 7.72	− 7.72	.33	7.9	1.0923	3.583	1.0580	+34.3	+0.113	W.
				Reverse	−1,687.2	+ .50										
				Mean	−1,686.7											
P. B. M. 36 A	P. B. M. 36	60	24.819	Direct	+1,201.3	+ .60	+ 8.32	− 8.32	.40	7.9	2.2942	7.527	2.2606	+33.6	+ .110	W.
				Reverse	+1,202.5	− .60										
				Mean	+1,201.9											
T. B. M. 178	T. B. M. 177	1,009	25.460	Direct	− 295.2	+ .70	+ 8.92	− 8.92	.47	7.9	2.5845					W.
				Reverse	− 293.8	− .70										
				Mean	− 294.5											
T. B. M. 179	T. B. M. 178	1,164	26.624	Direct	− 584.5	− .85	+ 8.07	− 8.07	.57	8.0	1.8991					W.
				Reverse	− 586.2	+ .85										
				Mean	− 585.35											
P. B. M. 2½	T. B. M. 179	62	26.686	Direct	−1,083.3	− .20	+ 7.87	− 7.87	.13	8.0	.8156	2.676	.7847	+31.0	+ .102	T.
				Reverse	−1,083.7	+ .20										
				Mean	−1,083.5											
P. B. M. 2½ A	T. B. M. 179	62	26.686	Direct	+ 120.3	.00	+ 8.07	− 8.07	.00	8.0	2.0194	6.625	1.9919	+27.5	+ .090	T.
				Reverse	+ 120.3	.00										
				Mean	+ 120.3											
T. B. M. 180	T. B. M. 179	2,476	29.100	Direct	+ 516.3	+1.65	+ 9.72	− 9.72	1.10	8.0	2.4171					T.
				Reverse	+ 519.6	−1.65										
				Mean	+ 517.95											

P. B. M. 35	T. B. M. 180	174	29.274	Direct	−1,533.0	.00	+ 9.72	− 9.72	.00	8.0	.8841	2.900	.8505	+33.6	+ .110	T.
				Reverse	−1,533.0	.00										
				Mean	−1,533.0											
P. B. M. 35 A	T. B. M. 180	174	29.274	Direct	− 328.7	.00	+ 9.72	− 9.72	.00	8.0	2.0684	6.852	2.0587	+34.7	+ .114	T.
				Reverse	− 328.7	.00										
				Mean	− 328.7											
T. B. M. 181	T. B. M. 180	3,880	32.980	Direct	−1,402.8	+1.00	+10.72	−10.72	.67	8.1	1.0158	.....	.....	.....	.....	T.
				Reverse	−1,400.8	−1.00										
				Mean	−1,401.8											
P. B. M. 2½ A	T. B. M. 181	254	33.234	Direct	+1,164.2	+ .25	+10.97	−10.97	.17	8.1	2.1802	7.158	2.1663	+13.9	+ .046	W.
				Reverse	+1,164.7	− .25										
				Mean	+1,164.45											
P. B. M. 2½	T. B. M. 181	254	33.234	Direct	− 37.8	− .45	+10.27	−10.27	.30	8.1	.9780	3.208	.9628	+15.2	+ .050	W.
				Reverse	− 38.2	+ .45										
				Mean	− 37.75											
T. B. M. 182	T. B. M. 181	1,758	34.738	Direct	+ 412.0	−1.75	+ 8.97	− 8.97	1.17	8.1	1.4260	.....	.....	.....	.....	W.
				Reverse	+ 408.5	+1.75										
				Mean	+ 410.25											
P. B. M. 34	T. B. M. 182	169	34,907	Direct	− 574.8	− .10	+ 8.87	− 8.87	.07	8.1	.8511	2.792	.8411	+10.0	+ .033	W.
				Reverse	− 575.0	+ .10										
				Mean	− 574.9											
T. B. M. 183	T. B. M. 182	1,101	35.839	Direct	+ 315.0	+2.10	+11.07	−11.07	1.40	8.3	1.7431	.....	.....	.....	.....	W.
				Reverse	+ 319.2	−2.10										
				Mean	+ 317.1											
T. B. M. 184	T. B. M. 183	908	36.747	Direct	+ 192.5	− .65	+10.42	−10.42	.48	8.3	1.9850	.....	.....	.....	.....	W.
				Reverse	+ 191.2	+ .65										
				Mean	+ 191.85											
P. B. M. 2½	T. B. M. 184	506	37.258	Direct	− 75.2	− .30	+10.12	−10.12	.20	8.3	1.8595	6.100	1.8445	+15.0	+ .049	W.
				Reverse	− 75.8	+ .30										
				Mean	− 75.5											

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V. Direct line.	Σ V. Reverse line.	r±.	R±.	Elevation above mean Gulf level. 1898.	Elevation above mean Gulf level. 1898.	Elevation above mean Gulf level. M. R. C. 1898.	Discrepancy.		Observer.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. 23° A	P. B. M. 23°	136	37.389	Direct	+1,206.7	+0.25	+10.37	−10.37	0.17	8.3	3.0664	10.060	3.0518	+14.6	+0.048	W.
				Reverse	+1,207.2	−0.25										
				Mean	+1,206.95											
T. B. M. 185	T. B. M. 184	1,565	38.312	Direct	+ 411.7	+ .15	+10.57	−10.57	.10	8.3	2.3468					W.
				Reverse	+ 412.0	− .15										
				Mean	+ 411.85											
T. B. M. 186	T. B. M. 185	658	38.965	Direct	− 383.0	+ .35	+10.92	−10.92	.23	8.3	1.9642					T.
				Reverse	− 382.3	− .35										
				Mean	− 382.65											
P. B. M. 33	T. B. M. 186	131	39.096	Direct	− 843.3	.00	+10.92	−10.92	.00	8.3	1.1209	3.677	1.1018	+19.1	+ .063	T.
				Reverse	− 843.3	.00										
				Mean	− 843.3											
P. B. M. 33 A	T. B. M. 186	131	39.096	Direct	+ 363.0	+ .35	+11.27	−11.27	.23	8.3	2.3275	7.636	2.3086	+18.9	+ .062	T.
				Reverse	+ 363.7	− .35										
				Mean	+ 363.35											
T. B. M. 187	T. B. M. 186	816	39.781	Direct	− 469.8	− .75	+10.17	−10.17	.50	8.3	1.4986					T.
				Reverse	− 471.3	+ .75										
				Mean	− 470.55											
T. B. M. 128	T. B. M. 187	1,474	41.255	Direct	− 131.9	−1.05	+ 9.12	− 9.12	.70	8.3	1.3607					T.
				Reverse	− 134.0	+1.05										
				Mean	− 132.95											
P. B. M. 24¹	T. B. M. 188	159	41.414	Direct	− 91.3	− .35	+ 8.77	− 8.77	.23	8.3	1.2690	4.163	1.2523	+16.7	+ .055	T.
				Reverse	− 92.0	+ .35										
				Mean	− 91.65											

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TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 186 Paige	T. B. M. 193	162	46.210	Direct	+ 38.8	−0.30	+11.42	−11.42	0.20	8.4	1.9847	6.347	1.9234	+11.3	+0.037	W.
				Reverse	+ 38.2	+ .30										
				Mean	+ 38.5											
T. B. M. 194	T. B. M. 193	1,182	47.280	Direct	− 471.7	+ .95	+12.67	−12.67	.63	8.4	1.4254					W.
				Reverse	− 469.8	− .95										
				Mean	− 470.75											
P. B. M. 31	T. B. M. 194	27	47.257	Direct	− 870.2	− .15	+12.52	−12.52	.10	8.4	.5551	1.821	.5882	+21.9	+ .072	W.
				Reverse	− 870.5	+ .15										
				Mean	− 870.35											
P. B. M. 31 A	T. B. M. 194	27	47.257	Direct	+ 336.7	+ .05	+12.72	−12.72	.08	8.4	1.7622	5.781	1.7887	+28.5	+ .077	W.
				Reverse	+ 336.8	− .05										
				Mean	+ 336.75											
T. B. M. 195	T. B. M. 194	1,700	48.980	Direct	− 34.0	+ .90	+13.57	−13.57	.60	8.4	1.3923					W.
				Reverse	− 32.2	− .90										
				Mean	− 33.10											
T. B. M. 195 A	T. B. M. 195	755	49.685	Direct	+ 782.3	+1.20	+14.77	−14.77	.80	8.5	2.1758					T.
				Reverse	+ 784.7	−1.20										
				Mean	+ 783.5											
T. B. M. 196	T. B. M. 195 A	611	50.296	Direct	+ 102.7	+ .80	+15.57	−15.57	.53	8.5	2.2798					T.
				Reverse	+ 104.3	− .80										
				Mean	+ 103.5											
Ⓐ Berthoud	T. B. M. 196	232	50.528	Direct	+ 321.7	− .85	+15.22	−15.22	.23	8.5	2.6007	8.532	2.5895	+14.2	+ .047	T.
				Reverse	+ 321.0	+ .85										
				Mean	+ 321.35											

T. B. M. 196 A	T. B. M. 196	719	51.015	Direct	106.0	+.35										T.
				Reverse	− 104.3	− .35										
				Mean	− 105.15				−16.42	.57	8.5	1.1742				
T. B. M. 197	T. B. M. 196 A	753	51.768	Direct	− 480.0	+1.00	+17.42									
				Reverse	− 478.0	−1.00			−17.42	.67	8.5	1.6952				T.
				Mean	− 479.0											
T. B. M. 198	T. B. M. 197	927	52.695	Direct	− 182.7	−2.00	+15.42		−15.42	1.33	8.6	1.5105				T.
				Reverse	− 186.7	+2.00										
				Mean	− 184.7											
P. B. M. 30 A	T. B. M. 198	140	52.835	Direct	+ 556.7	+ .15	+15.57		−15.57	.10	8.6	2.0673	6.783	2.0482	+19.1	+ .063	T.
				Reverse	+ 557.0	− .15										
				Mean	+ 556.85											
P. B. M. 30	T. B. M. 198	140	52.835	Direct	− 651.6	.00	+15.42		−15.42	.00	8.6	.8589	2.818	.8415	+17.4	+ .057	T.
				Reverse	− 651.6	.00										
				Mean	− 651.6											
T. B. M. 199	T. B. M. 198	1,742	54.437	Direct	+ 35.3	− .50	+14.92		−14.92	.33	8.7	1.5458				T.
				Reverse	+ 34.3	+ .50										
				Mean	+ 34.8											
P. B. M. 2¾4	T. B. M. 199	928	55.365	Direct	−1,001.3	− .70	+14.22		−14.22	.47	8.7	.5433	1.782	.5254	+17.9	+ .059	T.
				Reverse	−1,002.7	+ .70										
				Mean	−1,002.0											
T. B. M. 200	P. B. M. 2¾4	15	55.380	Direct	+ 822.5	+ .10	+14.32		−14.32	.07	8.7	1.3659				W.
				Reverse	+ 822.7	− .10										
				Mean	+ 822.6											
T. B. M. 201	T. B. M. 200	2,182	57.562	Direct	+ 265.5	+2.10	+16.42		−16.42	1.40	8.8	1.6335				W.
				Reverse	+ 269.7	−2.10										
				Mean	+ 267.6											
P. B. M. 29	T. B. M. 201	12	57.574	Direct	−1,020.3	.00	+16.42		−16.42	.00	8.8	.6132	2.011	.5859	+27.3	+ .090	W.
				Reverse	−1,020.3	.00										
				Mean	−1,020.3											

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. 29 A	T. B. M. 201	12	57.574	Direct	+ 184.5	−0.10	+16.32	−16.32	0.07	8.8	1.8179	5.964	1.7925	+25.4	+0.083	W.
				Reverse	+ 184.3	+0.10										
				Mean	+ 184.4											
T. B. M. 202	T. B. M. 201	1,021	58.583	Direct	+ 717.2	− .85	+15.57	−15.57	.57	8.8	2.3498					W.
				Reverse	+ 715.5	+ .85										
				Mean	+ 716.35											
T. B. M. 124, Paige	T. B. M. 202	1,272	59.855	Direct	+ 33.7	+1.75	+17.82	−17.82	1.17	8.9	2.3853	7.825	2.3628	+22.5	+ .074	W.
				Reverse	+ 37.2	−1.75										
				Mean	+ 35.45											
P. B. M. 23[s]	T. B. M. 124, Paige.	65	59.920	Direct	−1,307.3	− .25	+17.07	−17.07	.17	8.9	1.0777	3.536	1.0583	+19.4	+ .064	W.
				Reverse	−1,307.8	+ .25										
				Mean	−1,307.55											
P. B. M. 23[s] A	T. B. M. 124 (Paige).	65	59.920	Direct	− 95.8	+ .15	+17.47	−17.47	.10	8.9	2.2896	7.512	2.2720	+17.6	+ .058	W.
				Reverse	− 95.5	− .15										
				Mean	− 95.65											
T. B. M. 208	T. B. M. 124 (Paige).	2,004	61.859	Direct	−1,068.5	− .65	+16.67	−16.67	.43	8.9	1.3161					W.
				Reverse	−1,069.8	+ .65										
				Mean	−1,069.15											
T. B. M. 204	T. B. M. 208	868	62.727	Direct	− 224.0	+ .35	+17.02	−17.02	.28	8.9	1.0925					T.
				Reverse	− 223.3	− .35										
				Mean	− 223.65											
P. B. M. 28; new position	T. B. M. 204	66	62.793	Direct	− 733.3	− .20	+16.82	−16.82	.18	8.9	.3590	1.177				T.
				Reverse	− 733.7	+ .20										
				Mean	− 733.5											

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TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. 25½.....	T. B. M. 114, Paige.	51	69.455	Direct.....	−1,078.2	−0.05	+17.52	−17.52	0.03	9.0	0.6847	2.246	0.6621	+22.6	+0.074	W.
				Reverse.....	−1,078.3	+ .05										
				Mean....	−1,078.25											
P. B. M. 25½ "A".....	T. B. M. 114, Paige.	51	69.455	Direct.....	+ 131.7	+ .15	+17.72	−17.72	.10	9.0	1.8948	6.216	1.8734	+21.4	+ .070	W.
				Reverse.....	+ 132.0	− .15										
				Mean....	+ 131.85											
T. B. M. 209.....	T. B. M. 114, Paige.	781	70.185	Direct.....	− 150.0	− .90	+16.67	−16.67	.60	9.0	1.6120	.....	.....	.....	.....	W.
				Reverse.....	− 151.8	+ .90										
				Mean....	− 150.9											
T. B. M. 210.....	T. B. M. 209....	1,241	71.426	Direct.....	+ 103.2	−1.50	+15.17	−15.07	1.00	9.0	1.7137	.....	.....	.....	.....	W.
				Reverse.....	+ 100.2	+1.50										
				Mean....	+ 101.7											
P. B. M. 26.....	T. B. M. 210....	44	71.470	Direct.....	− 691.0	− .10	+15.07	−15.17	.07	9.0	1.0226	3.355	.9996	+23.0	+ .075	W.
				Reverse.....	− 691.2	+ .10										
				Mean....	− 691.1											
P. B. M. 26 "A".....	T. B. M. 210.....	44	71.470	Direct.....	+ 521.2	.00	+15.17	−15.17	.00	9.0	2.2351	7.332	2.2101	+25.0	+ .082	W.
				Reverse.....	+ 521.2	.00										
				Mean....	+ 521.2											
T. B. M. 211.....	T. B. M. 210.....	2,080	73.456	Direct.....	+ 63.7	+ .25	+15.42	−15.42	.17	9.1	1.7777	.....	.....	.....	.....	W.
				Reverse.....	+ 64.2	− .25										
				Mean....	+ 63.95											
T. B. M. 212.....	T. B. M. 211.....	438	73.894	Direct.....	+ 404.2	+ .90	+16.32	−16.32	.60	9.1	2.1828	.....	.....	.....	.....	W.
				Reverse.....	+ 406.0	− .90										
				Mean....	+ 405.1											

P. B. M. 2[2]	T. B. M. 212	221	74.115	Direct	−1,262.2	− .25	+16.07	−16.07	.17	9.1	.9208	3.019	.9064	+13.9	+ .046	W.
				Reverse	−1,262.7	+ .25										
				Mean	−1,262.45											
P. B. M. 2[2] "A"	T. B. M. 212	221	74.115	Direct	− 53.2	− .15	+16.17	−16.17	.10	9.1	2.1294	6.986	2.1162	+13.2	+ .043	W.
				Reverse	− 53.5	+ .15										
				Mean	− 53.35											
T. B. M. 213	T. B. M. 212	1,301	75.196	Direct	− 589.7	+ .50	+16.82	−16.82	.33	9.1	1.5086	.....	.....	.....	.....	T.
				Reverse	− 588.7	− .50										
				Mean	− 589.2											
T. B. M. 214	T. B. M. 213	1,507	76.702	Direct	− 149.7	−1.50	+15.32	−15.32	1.00	9.1	1.4424	.....	.....	.....	.....	T.
				Reverse	− 152.7	+1.50										
				Mean	− 151.2											
P. B. M. 25	T. B. M. 214	157	76.859	Direct	− 870.0	+ .35	+15.67	−15.67	.23	9.1	.5727	1.879	.5563	+16.4	+ .054	T.
				Reverse	− 869.3	− .35										
				Mean	− 869.65											
P. B. M. 25 "A"	T. B. M. 214	157	76.859	Direct	+ 338.3	− .15	+15.17	−15.17	.10	9.1	1.7805	5.841	1.7689	+16.6	+ .054	T.
				Reverse	+ 338.0	+ .15										
				Mean	+ 338.15											
T. B. M. 215	T. B. M. 214	1,589	78.291	Direct	− 120.7	− .15	+15.17	−15.17	.10	9.1	1.3215	.....	.....	.....	.....	T.
				Reverse	− 121.0	+ .15										
				Mean	− 120.85											
P. B. M. 2[3]	T. B. M. 215	1,321	79.612	Direct	− 616.2	− .05	+15.12	−15.12	.03	9.1	.7053	2.314	.6771	+28.2	+ .093	T.
				Reverse	− 616.3	+ .05										
				Mean	− 616.25											
P. B. M. 2[3] "A"	P. B. M. 2[3]	151	79.763	Direct	+1,203.0	.00	+15.12	−15.12	.00	9.1	1.9063	6.261	1.8824	+25.9	+ .085	T.
				Reverse	+1,203.0	.00										
				Mean	+1,203.0											
P. B. M. 24	P. B. M. 2[3]	1,694	81.306	Direct	+2,353.7	−1.85	+13.27	−13.27	1.23	9.2	3.0571	10.030	3.0890	−31.9	− .105	T.
				Reverse	+2,350.0	+1.85										
				Mean	+2,351.85											

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 216	P. B. M. 24	1,587	82.893	Direct	−1,426.7	−1.00	+12.27	−12.27	0.67	9.2	1.6294					T.
				Reverse	−1,428.7	+1.00										
				Mean	−1,427.7											
P. B. M. 23	T. B. M. 216	17	82.910	Direct	− 947.3	+ .05	+12.32	−12.32	.08	9.2	.6822	2.238	0.6640	+18.2	+0.060	W.
				Reverse	− 947.2	− .05										
				Mean	− 947.25											
P. B. M. 23 "A"	T. B. M. 216	17	82.910	Direct	+ 262.8	+ .20	+12.47	−12.47	.13	9.2	1.8924	6.208	1.8748	+17.6	+ .058	W.
				Reverse	+ 263.2	− .20										
				Mean	+ 263.0											
T. B. M. 102 (Paige)	T. B. M. 216	1,535	84.428	Direct	− 336.8	−1.50	+10.77	−10.77	1.00	9.3	1.2911	4.236	1.2970	− 5.9	− .019	W.
				Reverse	− 339.8	+1.50										
				Mean	− 338.3											
P. B. M. 2½	T. B. M. 102 (Paige).	84	84.512	Direct	− 798.5	− .10	+10.67	−10.67	.07	9.3	.4925	1.616	.4815	+11.0	+ .036	W.
				Reverse	− 798.7	+ .10										
				Mean	− 798.6											
P. B. M. 2½ "A"	T. B. M. 102 (Paige).	84	84.512	Direct	+ 407.3	+ .10	+10.87	−10.87	.07	9.3	1.6985	5.573	1.6902	+ 8.3	+ .027	W.
				Reverse	+ 407.5	− .10										
				Mean	+ 407.4											
T. B. M. 217	T. B. M. 102 (Paige).	1,049	85.477	Direct	+ 203.7	+1.00	+11.77	−11.77	.67	9.3	1.4958					W.
				Reverse	+ 205.7	−1.00										
				Mean	+ 204.7											
P. B. M. 22 "A"	T. B. M. 217	1,052	86.529	Direct	+ 818.2	−2.10	+ 9.67	− 9.67	1.40	9.4	2.3119	7.585	2.2810	+30.9	+ .101	W.
				Reverse	+ 814.0	+2.10										
				Mean	+ 816.1											

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TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1893.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 223.....	T. B. M. 222.....	434	94.915	Direct.....	+ 234.2	−0.35	+ 9.32	− 9.32	0.23	9.6	1.7341	.....	.....	.....	.....	W.
				Reverse.....	+ 233.5	+ .35										
				Mean....	+ 233.85											
P. M. B. 21[2].....	T. B. M. 223.....	53	94.568	Direct.....	−1,259.5	.00	+ 9.32	− 9.32	.00	9.6	.4746	1.557	0.4466	+28.0	+0.092	W.
				Reverse.....	−1.259.5	.00										
				Mean....	−1,259.5											
P. M. B. 21[2] A.....	T. B. M. 223.....	53	94.568	Direct.....	− 53.5	− .35	+ 8.97	− 8.97	.23	9.7	1.6802	5.512	1.6516	+28.6	+ .094	W.
				Reverse.....	− 54.2	+ .35										
				Mean....	− 53.85											
T. B. M. 91 (Paige)....	T. B. M. 223.....	1,084	95.599	Direct.....	− 1.8	− .60	+ 8.72	− 8.72	.40	9.7	1.7817	5.681	1.7163	+15.4	+ .051	W.
				Reverse.....	− 3.0	+ .60										
				Mean....	− 2.4											
T. B. M. 89 (Paige)....	T. B. M. 91 (Paige)	980	96.579	Direct.....	− .8	+1.05	+ 9.77	− 9.77	.70	9.7	1.7824	5.683	1.7098	+22.6	+ .074	W.
				Reverse.....	+ 1.8	−1.05										
				Mean....	+ .75											
P. B. M. 20.....	T. B. M. 89 (Paige)	55	96.634	Direct.....	−1,039.2	+ .10	+ 9.87	− 9.87	.07	9.7	.6983	2.274	.6714	+21.9	+ .072	W.
				Reverse.....	−1,039.0	− .10										
				Mean....	−1,039.1											
P. B. M. 20 A.....	T. B. M. 89 (Paige)	55	96.634	Direct.....	+ 163.7	− .20	+ 9.57	− 9.57	.13	9.7	1.8959	6.220	1.8744	+21.5	+ .071	W.
				Reverse.....	+ 163.3	+ .20										
				Mean....	+ 163.5											
T. B. M. 224.....	T. B. M. 89 (Paige)	1,051	97.630	Direct.....	− 711.3	+ .05	+ 9.82	− 9.82	.08	9.7	1.0212	.....	.....	.....	.....	W.
				Reverse.....	− 711.2	− .05										
				Mean....	− 711.25											

T. B. M. 225	T. B. M. 224	797	98.427	Direct Reverse	+ 846.7 + 846.0	− .35 + .35	+ 9.47	− 9.47	.28	9.7	1.8075				
				Mean	+ 846.35										T.
P. B. M. 4½	T. B. M. 225	132	98.559	Direct Reverse	−1,051.4 −1,051.4	.00 .00	+ 9.47	− 9.47	.00	9.7	.8161	2.677	a 7.928	+28.8	+ .076
				Mean	−1,051.4										T.
P. B. M. 4½ A	T. B. M. 225	132	98.559	Direct Reverse	+ 160.0 + 160.0	.00 .00	+ 9.47	− 9.47	.00	9.7	2.0275	6.652	a 1.9968	+30.7	+ .101
				Mean	+ 160.0										T.
T. B. M. 226	T. B. M. 225	1,321	99.748	Direct Reverse	− 440.1 − 439.0	+ .55 − .55	+10.02	−10.02	.37	9.7	1.4280				
				Mean	− 439.55										T.
T. B. M. 227	T. B. M. 226	885	100.633	Direct Reverse	+ 199.0 + 198.2	− .40 + .40	+ 9.62	− 9.62	.27	9.7	1.6266				
				Mean	+ 198.6										T.
P. B. M. 19	T. B. M. 227	138	100.771	Direct Reverse	− 362.0 − 362.0	.00 .00	+ 9.62	− 9.62	.00	9.7	1.2646	4.149	1.2399	+24.7	+ .061
				Mean	− 362.0										T.
P. B. M. 19 A	T. B. M. 227	138	100.771	Direct Reverse	+ 845.3 + 844.7	− .30 + .30	+ 9.32	− 9.32	.20	9.7	2.4716	8.109	2.4439	+22.7	+ .074
				Mean	+ 845.0										T.
T. B. M. 228	T. B. M. 227	1,484	102.117	Direct Reverse	− 359.7 − 363.8	−1.80 +1.80	+ 7.82	− 7.82	1.20	9.8	1.2651				
				Mean	− 361.5										T.
(A) White	T. B. M. 228	94	102.211	Direct Reverse	+ 489.3 + 489.3	.00 .00	+ 7.82	− 7.82	.00	9.8	1.7544	5.756	1.7486	+ 5.8	+ .019
				Mean	+ 489.3										T.
T. B. M. 84 (Paige)	T. B. M. 228	1,306	103.423	Direct Reverse	+ 475.7 + 473.0	−1.35 −1.35	+ 6.47	− 6.47	.90	9.8	1.7394	5.706	1.7346	+ 4.8	+ .016
				Mean	+ 474.35										T.

a Ordinary levels.

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. $^{2}\frac{1}{4}^{A}$	T. B. M. 84 (Paige)	63	103.486	Direct	−1,141.0	−0.35	+ 6.12	− 6.12	0.23	9.8	0.5981	1.962	0.5734	+24.7	+0.081	T.
				Reverse	−1,141.7	+ .35										
				Mean	−1,141.35											
P. B. M. $^{2}\frac{1}{4}^{A}$ A	T. B. M. 84 (Paige)	63	103.486	Direct	+ 73.3	− .15	+ 6.82	− 6.82	.10	9.8	1.8126	5.947	1.7848	+27.8	+ .091	T.
				Reverse	+ 73.0	+ .15										
				Mean	+ 73.15											
T. B. M. 229	T. B. M. 84 (Paige)	1,262	104.685	Direct	+ 170.3	−1.50	+ 4.97	− 4.97	1.00	9.9	1.9082					T.
				Reverse	+ 167.8	+1.50										
				Mean	+ 168.8											
T. B. M. 230	T. B. M. 229	1,026	105.711	Direct	− 693.8	− .10	+ 4.87	− 4.87	.07	9.9	1.2143					W.
				Reverse	− 694.0	+ .10										
				Mean	− 693.9											
P. B. M. 18	T. B. M. 230	67	105.778	Direct	− 887.5	+ .10	+ 4.97	− 4.97	.07	9.9	.3269	1.072	.3105	+16.4	+ .054	W.
				Reverse	− 887.3	− .10										
				Mean	− 887.4											
P. B. M. 18 A	T. B. M. 230	67	105.778	Direct	+ 316.7	.00	+ 4.87	− 4.87	.00	9.9	1.5310	5.023	1.5193	+11.7	+ .038	W.
				Reverse	+ 316.7	.00										
				Mean	+ 316.7											
T. B. M. 231	T. B. M. 230	1,504	107.215	Direct	+ 649.3	+1.50	+ 6.37	− 6.37	1.00	9.9	1.8651					W.
				Reverse	+ 652.3	−1.50										
				Mean	+ 650.8											
T. B. M. 232	T. B. M. 231	1,096	108.311	Direct	+ 88.3	+ .70	+ 7.07	− 7.07	.47	9.9	1.9541					W.
				Reverse	+ 89.7	− .70										
				Mean	+ 89.0											

T. B. M. 233	T. B. M. 232	645	108.956	Direct Reverse Mean	− 136.7 − 139.7 − 138.2	−1.50 +1.50 .00	+ 5.57	− 5.57	1.00	10.0	1.8150					W.
P. B. M. 2^{gs}	T. B. M. 233	56	109.012	Direct Reverse Mean	−1,383.5 −1,383.5 −1,383.5	.00 .00 .00	+ 5.57	− 5.57	.00	10.0	.4324	1.418	.4469	−14.5	− .048	W.
P. B. M. 2^{gs} A	T. B. M. 233	56	109.012	Direct Reverse Mean	− 171.8 − 171.8 − 171.8	.00 .00 .00	+ 5.57	− 5.57	.00	10.0	1.6441	5.894	1.6569	−12.8	− .042	W.
T. B. M. 234	T. B. M. 233	1,202	110.158	Direct Reverse Mean	+ 170.2 + 170.0 + 170.1	− .10 + .10 .00	+ 5.47	− 5.47	.07	10.0	1.9860					W.
T. B. M. 235	T. B. M. 234	706	110.864	Direct Reverse Mean	− 651.0 − 651.2 − 651.1	− .10 + .10 .00	+ 5.37	− 5.37	.07	10.0	1.3349					W.
P. B. M. 17	T. B. M. 235	102	110.966	Direct Reverse Mean	−1,053.0 −1,053.0 −1,053.0	.00 .00 .00	+ 5.37	− 5.37	.00	10.0	.2819	.925	.2618	+20.1	+ .066	T.
P. B. M. 17 A	T. B. M. 235	102	110.966	Direct Reverse Mean	+ 196.7 + 196.0 + 196.35	− .35 + .35 .00	+ 5.02	− 5.02	.23	10.0	1.5813	5.024	1.4692	+62.1	+ .204	T.
T. B. M. 236	T. B. M. 235	1,485	112.349	Direct Reverse Mean	− 222.0 − 220.7 − 221.35	+ .65 − .65 .00	+ 6.02	− 6.02	.43	10.0	1.1136					T.
T. B. M. 237	T. B. M. 236	763	113.112	Direct Reverse Mean	+ 593.3 + 593.0 + 593.15	− .15 + .15 .00	+ 5.87	− 5.87	.10	10.0	1.7067					T.
P. B. M. 2^{gs}	T. B. M. 237	79	113.191	Direct Reverse Mean	−1,351.7 −1,352.3 −1,352.0	− .30 + .30 .00	+ 5.57	− 5.57	.20	10.0	.3547	1.164	.3389	+15.8	+ .052	T.

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. $\frac{24}{A}$ A	T. B. M. 237	79	113.191	Direct	− 148.0	0.00	+ 5.87	− 5.87	0.00	10.0	1.5587	5.114	1.5445	+14.2	+0.047	T.
				Reverse	− 148.0	.00										
				Mean	− 148.0											
T. B. M. 238	T. B. M. 237	1,267	114.379	Direct	− 372.3	− .35	+ 5.52	− 5.52	.23	10.0	1.3341					T.
				Reverse	− 373.0	+ .35										
				Mean	− 372.65											
P. B. M. 16	T. B. M. 238	761	115.140	Direct	− 765.0	−1.00	+ 4.52	− 4.52	.67	10.0	.5681	1.863	.5517	+16.4	+ .054	T.
				Reverse	− 767.0	+1.00										
				Mean	− 766.0											
P. B. M. 16 A	P. B. M. 16	95	115.235	Direct	+1,206.0	+ .15	+ 4.67	− 4.67	.10	10.0	1.7742	5.821	1.7581	+16.1	+ .058	T.
				Reverse	+1,206.3	− .15										
				Mean	+1,206.15											
T. B. M. 239	P. B. M. 16	1,394	116.534	Direct	+1,035.0	+1.15	+ 5.67	− 5.67	.77	10.0	1.6042					T.
				Reverse	+1,037.3	−1.15										
				Mean	+1,036.15											
T. B. M. 240	T. B. M. 239	579	117.113	First direct	− 419.3	+ .98	+ 7.15	− 7.15	.63	10.1	1.1859					T.
				First reverse	− 416.0	−2.32										
				Second direct	− 420.3	+1.98										
				Second reverse	− 417.7	− .62										
				Mean	− 418.32											
P. B. M. $\frac{24}{Y}$	T. B. M. 240	538	117.651	Direct	− 639.7	+1.00	+ 8.15	− 8.15	.67	10.1	.5472	1.795	.5277	+19.5	+ .064	T.
				Reverse	− 637.7	−1.00										
				Mean	− 638.7											

P. B. M. 2[g'] A	P. B. M. 2[g']	42	117.693	Direct Reverse Mean	+1,206.8 +1,206.7 +1,206.0	— .30 + .30	+ 7.85	— 7.85	.20	10.1	1.7652	5.762	1.7804	+22.8	+ .076	T.
P. B. M. 15	P. B. M. 2[g']	1,722	119.373	Direct Reverse Mean	+1,123.1 +1,122.5 +1,122.8	— .30 + .30	+ 7.85	— 7.85	.20	10.1	1.6700	5.479	1.6497	+20.8	+ .067	W.
T. B. M. 241	P. B. M. 15	1,053	120.426	Direct Reverse Mean	— 122.8 — 121.8 — 122.05	+ .25 — .25	+ 8.10	— 8.10	.17	10.1	1.5480					W.
T. B. M. 242	T. B. M. 241	554	120.980	Direct Reverse Mean	— 254.0 — 253.0 — 253.5	+ .50 — .50	+ 8.60	— 8.60	.33	10.1	1.2944					W.
P. B. M. 14	T. B. M. 242	14	120.994	Direct Reverse Mean	— 897.5 — 897.3 — 897.4	+ .10 — .10	+ 8.70	— 8.70	.07	10.1	.8970	1.802	.8780	+24.0	+ .079	W.
P. B. M. 14 A	T. B. M. 242	14	120.994	Direct Reverse Mean	+ 306.0 + 305.8 + 305.9	— .10 + .10	+ 8.50	— 8.50	.07	10.1	1.6004	5.250	1.5776	+22.8	+ .075	W.
T. B. M. 243	T. B. M. 242	878	121.858	Direct Reverse Mean	+ 978.8 + 977.0 + 975.4	+1.60 —1.60	+10.20	—10.20	1.07	10.1	2.2698					W.
T. B. M. 244	T. B. M. 243	917	122.775	First direct First reverse Second direct Second reverse Mean	— 935.3 — 931.2 — 934.3 — 932.8 — 933.4	+1.90 —2.20 + .90 — .60	+11.60	—11.60	.60	10.2	1.8364					W.
P. B. M. 2[g']	T. B. M. 244	31	122.806	Direct Reverse Mean	— 723.0 — 723.3 — 723.15	— .15 + .15	+11.45	—11.45	.10	10.2	.6133	2.012	.5689	+44.4	+ .146	W.
P. B. M. 2[g'] A	T. B. M. 244	31	122.806	Direct Reverse Mean	+ 476.7 + 476.3 + 476.5	— .20 + .20	+11.25	—11.25	.13	10.2	1.8130	5.948	1.7733	+39.7	+ .130	W.

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 245	T. B. M. 244	699	123.474	Direct	+1,413.7	+0.80	+12.40	−12.40	0.58	10.2	2.7510					W.
				Reverse	+1,415.3	− .80										
				Mean	+1,414.5											
T. B. M. 246	T. B. M. 245	857	124.331	Direct	−1,502.3	− .85	+11.55	−11.55	.57	10.2	1.2478					T.
				Reverse	−1,504.0	+ .85										
				Mean	−1,503.15											
P. B. M. 13	T. B. M. 246	886	125.217	First direct	− 270.0	−4.22	+ 9.98	− 9.98	1.04	10.2	.9736	3.194	0.9677	+ 5.9	+0.019	T.
				First reverse	− 274.3	+ .08										
				Second direct	− 275.3	+1.08										
				Second reverse	− 277.3	+3.08										
				Mean	− 274.22											
P. B. M. 13 "A"	P. B. M. 13	79	125.296	Direct	+1,207.0	− .15	+ 9.73	− 9.73	.10	10.2	2.1804	7.154	2.1780	+ 2.4	+ .008	T.
				Reverse	+1,206.7	+ .15										
				Mean	+1,206.85											
T. B. M. 247	P. B. M. 13	1,046	126.268	First direct	+ 803.3	−2.65	+ 9.83	− 9.83	.96	10.3	1.7742					T.
				First reverse	+ 797.3	+3.35										
				Second direct	+ 799.3	+1.35										
				Second reverse	+ 802.7	−2.05										
				Mean	+ 800.65											
T. B. M. 248	T. B. M. 247	687	127.100	First direct	− 635.6	−3.22	+ 8.66	− 8.66	1.16	10.4	1.1354					T.
				First reverse	− 642.7	+3.88										
				Second direct	− 640.7	+1.88										
				Second reverse	− 636.3	−2.52										
				Mean	− 638.82											
P. B. M. 12	T. B. M. 248	19	127.119	Direct	+ 739.1	.00	+ 8.66	− 8.66	.00	10.4	1.8745	6.150	1.8578	+16.7	+ .055	T.
				Reverse	+ 739.1	.00										
				Mean	+ 739.1											

P. B. M. 11	T. B. M. 365	355	127.456	Direct	+ 377.7	+1.15	+ 9.81	− 9.81	.77	10.4	1.5148	4.968	1.4897	+24.5	+ .081	T.
				Reverse	+ 380.0	−1.15										
				Mean	+ 378.85											
P. B. M. 2[1]2	P. B. M. 11	49	127.507	Direct	− 709.3	− .20	+ 9.61	− 9.61	.13	10.4	.8048	2.640	.7699	+34.9	+ .115	T.
				Reverse	− 709.7	+ .20										
				Mean	− 709.5											
P. B. M. 2[1]2 A	P. B. M. 11	49	127.507	Direct	+ 498.3	− .15	+ 9.66	− 9.66	.10	10.4	2.0124	6.602	1.9775	+34.9	+ .115	T.
				Reverse	+ 498.0	+ .15										
				Mean	+ 498.15											
		88	127.496	Direct	+ 493.7	.00	+ 9.81	− 9.81	.00	10.4	2.0080	.....	.....	.....	.....	T.
				Reverse	+ 493.7	.00										
T. B. M. 249	P. B. M. 11			Mean	+ 493.7											
Zero of Fort St. Philip gauge.	T. B. M. 249	119	127.615	Direct	−1,879.5	+ .85	+10.16	−10.16	.28	10.4	.1288	.422	.....	.....	.....	T.
				Reverse	−1,878.8	− .85										
				Mean	−1,879.15											
T. B. M. 250, river crossing.	T. B. M. 249	760	128.256	Direct	+ 77.42	− .56	+ 9.25	− 9.25	.37	10.4	2.0648	.....	.....	.....	.....	W. & T.
				Reverse	+ 76.30	+ .56										
				Mean	+ 76.86											
P. B. M. 10	T. B. M. 250	180	128.436	Direct	− 930.8	− .45	+ 8.80	− 8.80	.30	10.4	1.1536	3.785	1.1564	− 2.8	− .009	W.
				Reverse	− 931.7	+ .45										
				Mean	− 931.25											
P. B. M. 2[1]2	P. B. M. 10	74	128.510	Direct	− 615.3	.00	+ 8.80	− 8.80	.00	10.4	.5333	1.766	.5554	−17.1	− .056	W.
				Reverse	− 615.3	.00										
				Mean	− 615.3											
P. B. M. 2[1]2 A	P. B. M. 10	74	128.510	Direct	+ 591.2	+ .05	+ 8.85	− 8.85	.08	10.4	1.7448	5.725	1.7612	−16.4	− .054	W.
				Reverse	+ 591.3	− .05										
				Mean	+ 591.25											
B. M. A	P. B. M. 10	57	128.498	Direct	+ 294.3	+ .10	+ 8.90	− 8.90	.07	10.4	1.4480	4.751	1.4654	−17.4	− .057	W.
				Reverse	+ 294.5	− .10										
				Mean	+ 294.40											

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1893.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 251	P. B. M. 10	359	128.795	Direct	+ 418.7	−0.50	+ 8.30	− 8.30	0.33	10.4	1.5718	5.157				W.
				Reverse	+ 417.7	+0.50										
				Mean	+ 418.2											
Zero of Fort Jackson gauge.	T. B. M. 251	12	128.807	Direct	−2,083.3	+ .35	+ 8.65	− 8.65	.23	10.4	− .5112	−1.677	−0.5121	+ 0.9	+0.003	W.
				Reverse	−2,082.6	− .35										
				Mean	−2,082.95											
T. B. M. 61, Paige	T. B. M. 251	111	128.906	Direct	− 256.3	+ .25	+ 8.55	− 8.55	.17	10.4	1.3157	4.317	1.3286	−12.9	− .042	W.
				Reverse	− 255.8	− .25										
				Mean	− 256.05											
Experimental B. M.	T. B. M. 61 (Paige).	69	128.975	Direct	−1,051.5	+ .10	+ 8.65	− 8.65	.07	10.4	.2643	.867	.2623	+ 2.0	+ .007	W.
				Reverse	−1,051.3	− .10										
				Mean	−1,051.4											
Cap over experimental B. M.	T. B. M. 61 (Paige.)	69	128.975	Direct	+ 148.8	+ .35	+ 8.90	− 8.90	.23	10.4	1.4649	4.806				W.
				Reverse	+ 149.5	− .35										
				Mean	+ 149.15											
T. B. M. 252	P. B. M. 10	1,665	130.101	Direct	+1,036.6	+1.75	+10.55	−10.55	1.17	10.5	2.1920					W.
				Reverse	+1,040.2	−1.75										
				Mean	+1,038.45											
T. B. M. 253	T. B. M. 252	686	130.787	Direct	− 501.0	+ .15	+10.70	−10.70	.10	10.5	1.6912					W.
				Reverse	− 500.7	− .15										
				Mean	− 500.85											
P. B. M. 9	T. B. M. 253	22	130.809	Direct	−1,137.8	− .10	+10.60	−10.60	.07	10.5	.5533	1.815	.5560	−2.7	− .009	W.
				Reverse	−1,138.0	+ .10										
				Mean	−1,137.9											

P. B. M. 9A	T. B. M. 253	22	130.809	Direct Reverse	+ 66.0 + 65.8	− .10 + .10	+10.60	10.60	.07	10.5	1.7071	8.705	1.7688	2.9	.010	W.
				Mean	+ 65.9											
T. B. M. 254	T. B. M. 253	1,154	131.941	Direct Reverse	+ 152.8 + 155.7	+ 1.45 − 1.45	+12.15	−12.15	.97	10.5	1.8454					W.
				Mean	+ 154.25											
T. B. M. 255	T. B. M. 254	897	132.838	First direct First reverse Second direct Second reverse	− 629.7 − 623.7 − 631.0 − 627.7	+ 1.68 − 4.32 + 2.98 − .82	+14.47	−14.47	1.07	10.6	1.2174					W.
				Mean	− 628.02											
P. B. M. 2½	T. B. M. 255	33	132.871	Direct Reverse	− 809.8 − 809.5	+ .15 − .15	+14.62	+14.62	.10	10.6	.4078	1.338	.4081	+ 4.7	+ .015	W.
				Mean	− 809.65											
P. B. M. 2½A	T. B. M. 255	33	132.871	Direct Reverse	+ 388.2 + 388.0	− .10 + .10	+14.37	−14.37	.07	10.6	1.6055	5.268	1.6013	+ 4.2	+ .014	W.
				Mean	+ 388.1											
T. B. M. 256	T. B. M. 255	851	133.689	First direct First reverse Second direct Second reverse Third direct	− 159.3 − 154.7 − 158.7 − 154.3 − 153.5	+ 3.20 − 1.40 + 2.60 − 1.80 − 2.60	+16.07	−16.07	.81	10.6	1.0613					W.
				Mean	− 156.1											
T. B. M. 257	T. B. M. 256	1,726	135.415	Direct Reverse	+ 713.5 + 710.3	− 1.60 + 1.60	+14.47	−14.47	1.07	10.6	1.7732					W.
				Mean	+ 711.9											
P. B. M. 8	T. B. M. 257	162	135.577	Direct Reverse	−1,189.4 −1,189.0	+ .20 − .20	+14.67	−14.67	.13	10.7	.5840	1.916	.5751	+ 8.9	+ .029	T.
				Mean	−1,189.2											
P. B. M. 8A	T. B. M. 257	162	135.577	Direct Reverse	+ 14.0 + 15.0	+ .50 − .50	+14.97	−14.97	.33	10.7	1.7877	5.865	1.7799	+ 7.8	+ .026	T.
				Mean	+ 14.5											

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1893.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 258	T. B. M. 257	1,069	136.484	Direct	− 133.1	− 0.85	+13.62	−13.62	0.57	10.7	1.6392					T.
				Reverse	− 134.8	+ 0.85										
				Mean	− 133.95											
T. B. M. 259	T. B. M. 258	1,877	137.861	Direct	− 589.2	− 1.75	+11.87	−11.87	1.17	10.7	1.0483					T.
				Reverse	− 592.7	+ 1.75										
				Mean	− 590.95											
P. B. M. 2½1	T. B. M. 259	62	137.923	Direct	− 655.7	.00	+11.87	−11.87	.00	10.7	.3926	1.288	0.3859	+ 6.7	+0.022	T.
				Reverse	− 655.7	.00										
				Mean	− 655.7											
P. B. M. 2½1A	T. B. M. 259	62	137.923	Direct	+ 552.7	+ .15	+12.02	−12.02	.10	10.7	1.6012	5.253	1.5944	+ 6.8	+ .022	T.
				Reverse	+ 568.0	− .15										
				Mean	+ 552.85											
T. B. M. 260	T. B. M. 259	1,340	139.201	Direct	+ 370.4	− .20	+11.67	−11.67	.13	10.7	1.4185					T.
				Reverse	+ 370.0	+ .20										
				Mean	+ 370.2											
T. B. M. 261	T. B. M. 260	835	140.036	Direct	+ 108.0	− 1.00	+10.67	−10.67	.67	10.7	1.5255					T.
				Reverse	+ 106.0	+ 1.00										
				Mean	+ 107.00											
T. B. M. 262	T. B. M. 261	923	140.959	First direct	+ 132.7	− 3.18	+ 9.34	− 9.34	.74	10.8	1.6550					T.
				First reverse	+ 127.7	+ 1.82										
				Second direct	+ 119.0	+10.52										
				Second reverse	+ 128.7	+ .82										
				Third direct	+ 129.0	+ .52										
				Mean	+ 129.52											

P. B. M. 7	T. B. M. 263	75	141.084	Direct Reverse	−1,832.7 −1,833.0	−.15 +.15	+ 9.19	− 9.19	.10	10.8	.8253	1.057	.0190	+ 2.6	+ .009	T.
				Mean	−1,832.85											
P. B. M. 7A	T. B. M. 262	75	141.084	Direct Reverse	− 130.0 − 129.7	+.15 −.15	+ 9.49	− 9.49	.10	10.8	1.6252	5.004	1.5226	+ 2.6	+ .009	T.
				Mean	− 129.85											
T. B. M. 263	T. B. M. 262	680	141.689	Direct Reverse	+ 179.7 + 176.3	−1.70 +1.70	+ 7.64	− 7.64	1.13	10.8	1.8330					T.
				Mean	+ 178.0											
T. B. M. 264	T. B. M. 263	1,799	143.488	Direct Reverse	− 215.7 − 218.0	−1.15 +1.15	+ 6.49	− 6.49	.77	10.9	1.6162					T.
				Mean	− 216.85											
T. B. M. 265	T. B. M. 264	229	143.667	Direct Reverse	− 335.6 − 335.4	+.10 −.10	+ 6.59	− 6.59	.07	10.9	1.2307					W.
				Mean	− 335.5											
T. B. M. 24, Paige	T. B. M. 265	134	143.801	Direct Reverse	− 27.2 − 27.0	+.10 −.10	+ 6.69	− 6.69	.07	10.9	1.2586	4.113	1.3562	−102.6	− .337	W.
				Mean	− 27.10											
P. B. M. Jump; bolt in tile.	T. B. M. 24 (Paige)	50	143.851	Direct Reverse	− 686.5 − 686.7	−.10 +.10	+ 6.59	− 6.59	.07	10.9	.5670	1.860				W.
				Mean	− 686.6											
Cap over P. B. M. Jump.	T. B. M. 24 (Paige)	50	143.851	Direct Reverse	+ 525.8 + 526.2	+.20 −.20	+ 6.89	− 6.89	.13	10.9	1.7796	5.839				W.
				Mean	+ 526.00											
T. B. M. 266	T. B. M. 24 (Paige)	1,500	145.301	Direct Reverse	− 249.0 − 251.7	−1.35 +1.35	+ 5.34	− 5.34	.90	10.9	1.0032					W.
				Mean	− 250.35											
T. B. M. 267	T. B. M. 266	447	145.748	First direct First reverse Second direct Second reverse	+ 8.5 + 13.0 + 13.5 + 11.3	+3.08 −1.42 −1.92 +.28	+ 5.91	− 5.91	.76	10.9	1.0148					W.
				Mean	+ 11.58											

a Not used in mean.

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. 6 A	T. B. M. 267	485	146.233	Direct	+ 239.0	+ 1.10	+ 7.01	− 7.01	0.73	10.9	1.2549	4.117	1.3880	−138.1	−0.437	W.
				Reverse	+ 241.2	− 1.10										
				Mean	+ 240.1											
P. B. M. 6	P. B. M. 6 A	26	146.259	Direct	−1,213.2	− .15	+ 6.86	− 6.86	.10	10.9	.0416	.136	.1812	−139.6	− .458	W.
				Reverse	−1,213.5	+ .15										
				Mean	−1,213.35											
T. B. M. 268	P. B. M. 6 A	733	146.966	Direct	− 67.0	+ .25	+ 7.26	− 7.26	.17	11.0	1.1882					W.
				Reverse	− 66.5	− .25										
				Mean	− 66.75											
P. B. M. 269	T. B. M. 268	812	147.778	Direct	− 353.2	− .05	+ 7.21	− 7.21	.03	11.0	.8349					W.
				Reverse	− 353.3	+ .05										
				Mean	− 353.25											
T. B. M. 270	T. B. M. 269	264	148.042	First direct	+ 41.7	− 1.37	+ 5.88	− 5.88	.52	11.0	.8752					W.
				Reverse	+ 39.0	+ 1.33										
				Second direct	+ 40.3	+ .08										
				Mean	+ 40.33											
T. B. M. 271	T. B. M. 270	382	148.424	Direct	+ 436.3	+ .70	+ 6.58	− 6.58	.47	11.0	1.3122					T.
				Reverse	+ 437.7	− .70										
				Mean	+ 437.0											
P. B. M. 2$\frac{1}{2}$	T. B. M. 271	62	148.486	Direct	− 909.0	+ .15	+ 6.73	− 6.73	.10	11.0	.4084	1.324	*a* .5508	−147.4	− .484	T.
				Reverse	− 908.7	− .15										
				Mean	− 908.85											
P. B. M. 2$\frac{1}{2}$ A	T. B. M. 271	62	148.486	Direct	+ 294.7	− .20	+ 6.38	− 6.38	.13	11.0	1.6067	5.271	*a* 1.7551	−148.4	− .487	T.
				Reverse	+ 294.3	+ .20										
				Mean	+ 294.5											

T. B. M. 272														T.
T. B. M. 271	1,125	149.559	Direct	— 719.7										
			Reverse	— 722.0										
			Mean	— 720.85	+ .50	+ 6.98	— 5.98	.83	11.0	1.1596				
T. B. M. 272	1,065	150.624	Direct	+ 667.7	+ .50									
			Reverse	+ 668.7	— .50									
			Mean	+ 668.2		+ 6.78	— 6.78	.13	11.0	.8341	1.096	.8670	— 82.9	— .108
T. B. M. 273	27	150.651	Direct	— 825.8	— .20									T.
			Reverse	— 825.7	+ .20									
			Mean	— 825.5		+ 6.78	— 6.78	.10	11.0	1.5417	5.056	1.8767	— 84.0	— .112
P. B. M. 5 A	T. B. M. 273	27	150.651	Direct	+ 882.3	— .15								T.
				Reverse	+ 882.0	+ .15								
				Mean	+ 882.15		+ 6.78	— 5.78	.10	11.0	1.4096	4.625	a 1.4241	— 14.5	— .043
P. B. M. 244 A	T. B. M. 273	2,197	152.831	Direct	+ 250.7	— .70								T.
				Reverse	+ 249.3	+ .70								
				Mean	+ 250.0		+ 6.28	— 5.28	.47	11.0	1.4096	4.625	a 1.4241	— 14.5	— .043
P. B. M. 244	P. B. M. 244 A	20	152.841	Direct	— 1,208.2	— .15								W.
				Reverse	— 1,208.5	+ .15								
				Mean	— 1,208.35		+ 6.08	— 5.08	.10	11.0	.2022	.677	a .2195	— 13.3	— .044
T. B. M. 274	P. B. M. 244 A	1,168	153.989	Direct	— 483.3	— .95								W.
				Reverse	— 485.2	+ .95								
				Mean	— 484.25		+ 4.28	— 4.28	.63	11.0	.9253				
T. B. M. 275	T. B. M. 274	1,078	155.067	Direct	+ 5.8	+ .45								W.
				Reverse	+ 6.7	— .45								
				Mean	+ 6.25		+ 4.78	— 4.78	.80	11.0	.9316				
T. B. M. 276	T. B. M. 275	1,966	157.028	Direct	+ 10.0	— .90								W.
				Reverse	+ 8.2	+ .90								
				Mean	+ 9.1		+ 3.83	— 2.93	.60	11.0	.9407				
T. B. M. 277	T. B. M. 276	964	158.007	Direct	— 227.2	— 1.35								T.
				Reverse	— 229.9	+ 1.35								
				Mean	— 228.55		+ 2.48	— 2.48	.90	11.1	.7121			

a Ordinary levels.

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 278	T. B. M. 277	1,217	159.224	Direct	+ 276.0	− 1.65	+ 0.83	− 0.83	1.10	11.1	0.9865					T.
				Reverse	+ 272.7	+ 1.65										
				Mean	+ 274.35											
P. B. M. 3	T. B. M. 278	65	159.289	Direct	− 781.3	+ .15	+ .98	− .98	.10	11.1	.2053	0.673	0.3214	−116.1	−0.381	T.
				Reverse	− 781.0	− .15										
				Mean	− 781.15											
P. B. M. 3 A	T. B. M. 278	65	159.289	Direct	+ 421.7	− .20	+ .63	− .63	.13	11.1	1.4080	4.620	1.5204	−112.4	− .369	T.
				Reverse	+ 421.3	+ .20										
				Mean	+ 421.5											
T. B. M. 279	T. B. M. 278	2,050	161.274	Direct	− 74.3	.00	+ .83	− .83	.00	11.1	.9122					T.
				Reverse	− 74.3	.00										
				Mean	− 74.30											
P. B. M. 1, Southwest Pass.	T. B. M. 279	52	161.326	Direct	− 845.7	− .15	+ .68	− .68	.10	11.1	.0663	.218				T.
				Reverse	− 846.0	+ .15										
				Mean	− 845.85											
Cap on P. B. M. 1, Southwest Pass.	T. B. M. 279	52	161.326	Direct	+ 365.3	.00	+ .83	− .83	.00	11.1	1.2775	4.191				T.
				Reverse	+ 365.3	.00										
				Mean	+ 365.3											
T. B. M. 80, River Crossing, Southwest Pass.	T. B. M. 279	660	161.984	First direct	+ 52.7	+ 4.18	+ 3.11	− 3.11	1.16	11.2	.9691					W. and T.
				First reverse	+ 61.1	− 4.22										
				Second direct	+ 56.5	+ .38										
				Second reverse	+ 57.2	− .32										
				Mean	+ 56.88											

T. B. M. 281	T. B. M. 280	369	162.208	Direct	− 337.8	+ .15	+ 3.26	− 3.26	.10	11.2	.6319						W.
				Reverse	− 337.0	− .15											
				Mean	− 337.15												
P. B. M. 1	T. B. M. 281	45	162.343	Direct	− 500.5	− .35	+ 2.91	− 2.91	.23	11.2	.1811	.480	.1222	+ 8.9	+ .029	W.	
				Reverse	− 501.2	+ .35											
				Mean	− 500.85												
P. B. M. 1 A	T. B. M. 281	45	162.343	Direct	+ 706.3	− .05	+ 3.21	− 3.21	.08	11.2	1.3382	4.391	1.3298	+ 8.9	+ .029	W.	
				Reverse	+ 706.2	+ .05											
				Mean	+ 706.25												
P. B. M. Fire	T. B. M. 281	51	162.854	Direct	− 217.7	− .05	+ 3.21	− 3.21	.08	11.2	.4142	1.359	.3994	+ 14.8	+ .049	W.	
				Reverse	− 217.8	+ .05											
				Mean	− 217.75												
B. M. in light-house Head of Passes.	T. B. M. 281	12	162.815	Direct	+ 1139.0	.00	+ 3.26	− 3.26	.00	11.2	1.7709	5.810	1.7616	+ 9.8	+ .061	W.	
				Reverse	+ 1139.0	.00											
				Mean	+ 1139.0												
Zero of South Pass gauge.	T. B. M. 281	151	162.454	Direct	− 1168.0	− .35	+ 2.91	− 2.91	.23	11.2	− .5864	− 1.760	− .5529	+ 16.5	+ .054	W.	
				Reverse	− 1168.7	+ .35											
				Mean	− 1168.35												
Zero of gauge at boathouse.	T. B. M. 281	181	162.484	Direct	−1,170.3	− .10	+ 3.16	− 3.16	.07	11.2	− .5885	−1.767				W.	
				Reverse	−1,170.5	+ .10											
				Mean	−1,170.4												
T. B. M. 282	T. B. M. 281	1,068	163.371	First direct	+ 54.5	+ 2.38	+ 4.63	− 4.63	.64	11.2	.6888					W.	
				First reverse	+ 59.0	− 2.12											
				Second direct	+ 56.5	+ .38											
				Second reverse	+ 57.5	− .62											
				Mean	+ 56.88												
P. B. M. 9 A, South Pass.	T. B. M. 282	1,100	164.471	Direct	+ 306.7	+ .90	+ 5.53	− 5.53	.60	11.2	.9964	3.269	1.0099	− 13.5	− .044	W.	
				Reverse	+ 308.5	− .90											
				Mean	+ 307.6												
P. B. M. 9, South Pass.	P. B. M. 9 A	58	164.529	Direct	−1,204.7	+ .50	+ 6.08	− 6.08	.33	11.2	− .2078	− .682	− .1945	− 13.3	− .044	W.	
				Reverse	−1,203.7	− .50											
				Mean	−1,204.2												

TABLE No. 8.—*Tabulation of precise-level results from New Orleans, La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1893.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. 8 A, South Pass.	P. B. M. 9 A.....	1,537	166.008	Direct.....	+ 39.2	+ 0.75	+ 6.28	— 6.28	0.50	11.2	1.0363	3.400	1.0685	— 32.2	—0.106	W.
				Reverse.....	+ 40.7	— .75										
				Mean....	+ 39.95											
P. B. M. 8, South Pass.	P. B. M. 8 A.....	21	166.029	Direct.....	—1,206.7	+ .50	+ 6.78	— 6.78	.33	11.2	— .1699	— .557	— .1399	— 30.0	— .098	T.
				Reverse.....	—1,205.7	— .50										
				Mean....	—1,206.2											
T. B. M. 283.....	P. B. M. 8 A.....	1,796	167.804	Direct.....	— 420.0	+ 1.15	+ 7.43	— 7.43	.77	11.2	.6175	.....	.....	.....	.....	T.
				Reverse.....	— 417.7	— 1.15										
				Mean....	— 418.85											
P. B. M. 7, South Pass.	T. B. M. 283.....	239	168.043	Direct.....	— 891.7	— .80	+ 6.63	— 6.63	.53	11.3	— .2750	— .902	— .2328	— 42.7	— .140	T.
				Reverse.....	— 893.3	+ .80										
				Mean....	— 892.5											
P. B. M. 7 A, South Pass.	T. B. M. 283.....	239	168.043	Direct.....	+ 315.3	— .80	+ 6.63	— 6.63	.53	11.3	.9820	3.058	.9744	— 42.4	— .139	T.
				Reverse.....	+ 313.7	+ .80										
				Mean....	+ 314.5											
P. B. M. 6 A, South Pass.	T. B. M. 283.....	1,836	169.640	Direct.....	+ 294.7	+ 1.30	+ 8.73	— 8.73	.87	11.3	.9185	2.997	.9979	— 84.4	— .277	T.
				Reverse.....	+ 297.3	— 1.30										
				Mean....	+ 296.0											
P. B. M. 6, South Pass.	P. B. M. 6 A.....	77	169.717	Direct.....	—1,205.7	— .15	+ 8.58	— 8.58	.10	11.3	— .2924	— .959	— .2083	— 84.1	— .276	T.
				Reverse.....	—1,206.0	+ .15										
				Mean....	—1,205.85											
P. B. M. 5 A, South Pass.	P. B. M. 6 A.....	1,545	171.185	Direct.....	+ 459.3	+ 1.35	+10.08	—10.08	.90	11.3	1.3741	4.508	1.4023	— 28.2	— .093	T.
				Reverse.....	+ 462.0	— 1.35										
				Mean....	+ 460.65											

P. B. M. 5, South Pass.	P. B. M. 5 A	67	171.252	Direct Reverse	−1,205.0 −1,206.3	− +	.15 .15	+ 9.93	− 9.93	.10	11.3	.1690	.555	.1996	30.6	− .100	T.
				Mean	−1,205.15												
T. B. M. 284	P B. M. 5 A	818	172.008	Direct Reverse	− 686.7 − 688.0	− +	.65 .65	+ 9.43	− 9.43	.43	11.3	.6868					T.
				Mean	− 687.35												
P. B. M. 4 A, South Pass.	T. B. M. 284	822	172.825	Direct Reverse	+ 253.3 + 252.0	− +	.65 .65	+ 8.78	− 8.78	.43	11.3	.9894	3.062	.9675	− 28.1	− .092	W.
				Mean	+ 252.65												
P. B. M. 4, South Pass.	P. B. M. 4 A	93	172.918	Direct Reverse	−1,204.8 −1,204.8	− +	.25 .25	+ 8.53	− 8.53	.17	11.3	− .2651	− .870	− .2871	− 28.0	− .092	W.
				Mean	−1,204.55												
P. B. M. 3 A, South Pass.	P. B. M. 4 A	1,606	174.483	Direct Reverse	+ 2.8 + 6.7	+ −	1.95 1.95	+10.78	−10.78	1.80	11.4	.9442	3.098	.9686	− 24.4	− .080	W.
				Mean	+ 4.75												
P. B. M. 3, South Pass.	P. B. M. 3 A	88	174.521	Direct Reverse	−1,201.2 −1,201.0	+ −	.10 .10	+10.88	−10.83	.07	11.4	− .2569	− .843	− .2333	− 23.6	− .077	W.
				Mean	−1,201.1												
T. B. M. 285	P. B. M. 3 A	488	174.921	Direct Reverse	− 430.5 − 431.7	− +	.60 .60	+10.13	−10.13	.40	11.4	.5131					W.
				Mean	− 431.1												
P. B. M. 2 A, South Pass.	T. B. M. 285	1,121	176.042	Direct Reverse	+ 374.0 + 377.2	+ −	1.60 1.60	+11.78	−11.78	1.07	11.5	.8887	2.916	.9102	− 21.5	− .071	W.
				Mean	+ 375.6												
T. B. M. 286	P. B. M. 2 A	7	176.049	Direct Reverse	− 414.7 − 415.0	− +	.15 .15	+11.58	−11.58	.10	11.5	.4738					T.
				Mean	− 414.85												
P. B. M. 2, South Pass.	T. B. M. 286	7	176.056	Direct Reverse	− 791.0 − 791.0		.00 .00	+11.58	−11.58	.00	11.5	− .3172	−1.041	− .2960	− 21.2	− .070	T.
				Mean	− 791.0												

TABLE No. 8.—*Tabulation of precise-level results from New Orleans La., to mouth of South Pass, 1898*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r±	R±	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1898.	1898.	M. R. C. 1898.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 287	T. B. M. 286	837	176.886	Direct	− 87.1	− 0.10	+11.48	−11.48	0.07	11.5	0.3866					T.
				Reverse	− 87.8	+ .10										
				Mean	− 87.2											
T. B. M. 288	T. B. M. 287	898	177.779	Direct	+ 14.3	− .15	+11.33	−11.33	.10	11.5	.4008					T.
				Reverse	+ 14.0	+ .15										
				Mean	+ 14.15											
T. B. M. 289	T. B. M. 288	448	178.227	Direct	− 4.7	− 1.20	+10.13	−10.13	.80	11.5	.3949					T.
				Reverse	− 7.1	+ 1.20										
				Mean	− 5.9											
T. B. M. 290	T. B. M. 289	571	178.798	Direct	+ 583.8	− 1.35	+ 8.78	− 8.78	.90	11.5	.9773					T.
				Reverse	+ 581.1	+ 1.35										
				Mean	+ 582.45											
T. B. M. 291	T. B. M. 290	725	179.523	First direct	− 93.3	− 4.67	+ 6.23	− 6.23	.85	11.6	.8794					T.
				First reverse	− 99.9	+ 1.93										
				Second direct	− 95.0	− 2.97										
				Second reverse	− 101.3	+ 3.33										
				Third direct	− 98.0	+ .03										
				Third reverse	− 100.3	+ 2.33										
				Mean	− 97.97											
T. B. M. 293	T. B. M. 291	429	179.952	Direct	− 233.4	− .10	+ 6.13	− 6.13	.07	11.6	.6459					T.
				Reverse	− 233.6	+ .10										
				Mean	− 233.5											
B. M. "D"	T. B. M. 293	99	180.051	Direct	− 324.7	− .80	+ 5.33	− 5.33	.20	11.6	.8209	1.053	0.3884	− 17.5	−0.057	T.
				Reverse	− 325.3	+ .80										
				Mean	− 325.0											

B. M. "X"	B. M. "D"	36	180.087	Direct	− 49.7	+ .20	+ 6.08	− 6.08	.13	11.6	.2714	.891	.2920	− 20.6	− .068	T.
				Reverse	− 49.8	− .20										
				Mean	− 49.5											
Zero of Port Eads gauge.	B. M. "D"	65	180.116	Direct	−1,283.9	− .15	+ 5.68	− 5.68	.10	11.6	− .9632	−3.160				T.
				Reverse	−1,284.2	+ .15										
				Mean	−1,284.05											
Zero of East Bay gauge.	B. M. "D"	671	180.722	Direct	−1,282.5	+ .05	+ 5.88	− 5.88	.08	11.6	− .9616	−3.155				T.
				Reverse	−1,282.4	− .05										
				Mean	−1,282.45											
P. B. M. "I"	T. B. M. 291	50	179.573	Direct	+ 46.3	.00	+ 6.23	− 6.23	.00	11.6	.9257	3.087	.9323	− 6.6	− .022	T.
				Reverse	+ 46.3	.00										
				Mean	+ 46.3											
Zero of Garden Island Bay gauge.	P. B. M. "I"	204	179.777	Direct	−1,883.1	− .35	+ 5.88	− 5.88	.23	11.6	− .9578	−3.142				T.
				Reverse	−1,883.8	+ .35										
				Mean	−1,883.45											
T. B. M. 292	P. B. M. "I"	1,480	181.053	Direct	+ 151.3	+ .70	+ 6.98	− 6.98	.47	11.6	1.0777					T.
				Reverse	+ 152.7	− .70										
				Mean	+ 152.0											
T. B. M. 294	T. B. M. 292	755	181.808	Direct	+ 282.5	− 1.10	+ 5.83	− 5.83	.78	11.6	1.3591					W.
				Reverse	+ 280.3	+ 1.10										
				Mean	+ 281.4											
T. B. M. 295	T. B. M. 294	488	182.296	Direct	− 344.8	− .10	+ 5.73	− 5.73	.07	11.6	1.0142					W.
				Reverse	− 345.0	+ .10										
				Mean	− 344.9											
T. B. M. 296	T. B. M. 295	1,182	183.428	Direct	− 422.0	+ .65	+ 6.38	− 6.38	.43	11.6	.5928					W.
				Reverse	− 420.7	− .65										
				Mean	− 421.35											
P. B. M. "J"	T. B. M. 296	40	183.468	Direct	+ 208.1	− .15	+ 6.23	− 6.23	.10	11.6	.8008	2.627	1.0581	−257.3	− .844	W.
				Reverse	+ 207.8	+ .15										
				Mean	+ 207.95											

NOTE.—Probable error for kilometer = .68 millimeter.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98.*

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
City Stone "Halfway House."	.....	.....	.....	.....	.....	.....	.....	.....	.....	7.1	1.6391	5.378	(1882) 1.6049	+ 34.2	+0.112	
T. B. M. 155	City Stone "Halfway House."	29	0.029	Direct	+ 456.7	0.00	0.00	0.00	0.00	7.1	2.0958	.....	.....	.....	.....	T.
				Reverse	+ 456.7	.00										
				Mean	+ 456.7											
T. B. M. 154	T. B. M. 155	2,516	2.545	Direct	−1,259.7	+ .85	+ .85	− .85	.57	7.1	.8370	.....	.....	.....	.....	T.
				Reverse	−1,258.0	− .85										
				Mean	−1,258.85											
T. B. M. 159	T. B. M. 154	798	3.343	Direct	− 99.7	+ .50	+ 1.35	− 1.35	.38	7.1	.7378	.....	.....	.....	.....	W.
				Reverse	− 98.7	− .50										
				Mean	− 99.2											
City B. M. XX stone.	T. B. M. 159	1,494	4.837	Direct	+ 668.5	+ 1.50	+ 2.85	− 2.85	1.00	7.2	1.4078	4.618	(1882) 1.3834	+ 24.4	+ .080	W.
				Reverse	+ 671.5	− 1.50										
				Mean	+ 670.0											
T. B. M. 160	City B. M. XX stone.	315	5.152	First direct....	+ 503.2	+ 1.10	+ 3.05	− 3.05	.39	7.2	1.9121	6.273	.....	.....	.....	W.
				First reverse...	+ 505.5	− 1.20										
				Second direct .	+ 505.0	− .70										
				Second reverse.	+ 503.5	+ .80										
				Mean....	+ 504.3											
P. B. M., Carrollton ..	T. B. M. 160	81	5.188	Direct	+ 821.8	− .05	+ 3.00	− 3.00	.03	7.2	2.7338	8.969	(1882) 2.7657	− 31.9	− .105	W.
				Reverse	+ 821.7	+ .05										
				Mean....	+ 821.75											
Gauge-B. M., Carrollton gauge.	.....do	400	5.552	Direct	− 45.3	+ .40	+ 3.45	− 3.45	.27	7.2	1.8672	6.126	.....	.....	.....	W.
				Reverse	− 44.5	− .40										
				Mean....	− 44.9											

Cap over gauge B. M.	Gauge B. M.	14	5.566	Direct	+1,244.5	− .25	+ 3.20	− 3.20	.17	7.2	3.1114	10.208				W.
				Reverse	+1,244.0	+ .25										
				Mean	+1,244.25											
T. B. M. 153	T. B. M. 154	998	3.542	Direct	+ 104.7	− .35	+ .50	− .50	.23	7.1	.9414					T.
				Reverse	+ 104.0	+ .35										
				Mean	+ 104.35											
T. B. M. 152	T. B. M. 153	1,356	4.899	Direct	− 41.8	− .20	+ .30	− .30	.13	7.1	.8994					W.
				Reverse	− 42.2	+ .20										
				Mean	− 42.0											
B. M. $2\frac{1}{1}$	T. B. M. 152	488	5.387	Direct	− 745.2	− .50	− .20	+ .20	.33	7.1	.1586	.504	a .0697	+ 63.9	+ .210	W.
				Reverse	− 746.2	+ .50										
				Mean	− 745.7											
Cap over B. M. $2\frac{1}{1}$	B. M. $2\frac{1}{1}$	20	5.407	Direct	+1,204.0	+ .15	− .05	+ .05	.10	7.1	1.3578	4.454	a 1.2986	+ 64.2	+ .211	W.
				Reverse	+1,204.3	− .15										
				Mean	+1,204.15											
T. B. M. 151	T. B. M. 152	865	5.764	Direct	+ 219.5	− .10	+ .20	− .20	.07	7.1	1.1188					W.
				Reverse	+ 219.3	+ .10										
				Mean	+ 219.4											
T. B. M. 150	T. B. M. 151	940	6.704	Direct	+ 855.3	+ 1.60	+ 1.80	− 1.80	1.07	7.2	1.9756					W.
				Reverse	+ 858.5	− 1.60										
				Mean	+ 856.9											
T. B. M. 149	T. B. M. 150	698	7.402	Direct	− 94.7	+ 1.25	+ 3.05	− 3.05	.33	7.3	1.3822					W.
				Reverse	− 92.2	− 1.25										
				Mean	− 93.45											
T. B. M. 148	T. B. M. 149	1,102	8.504	Direct	− 2.2	− .75	+ 2.80	− 2.80	.50	7.3	1.8792					W.
				Reverse	− 3.7	+ .75										
				Mean	− 2.95											
T. B. M. 147	T. B. M. 148	568	9.072	Direct	+ 67.7	− .35	+ 1.95	− 1.95	.23	7.3	1.9466					T.
				Reverse	+ 67.0	+ .35										
				Mean	+ 67.35											

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 146	T. B. M. 147	754	9.826	First direct	− 169.0	− 4.82	+ 1.12	− 1.12	1.16	7.4	1.7728					T.
				First reverse	− 174.0	+ .18										
				Second direct	− 177.0	+ 3.18										
				Second reverse	− 175.3	+ 1.48										
				Mean	− 173.82											
T. B. M. 145	T. B. M. 146	1,875	11.201	Direct	− 291.3	+ .15	+ 1.27	− 1.27	.10	7.4	1.4816					T.
				Reverse	− 291.0	− .15										
				Mean	− 291.15											
T. B. M. 144	T. B. M. 145	1,880	12.581	Direct	− 103.7	− 1.00	+ .27	− .27	.67	7.4	1.8769					T.
				Reverse	− 105.7	+ 1.00										
				Mean	− 104.7											
T. B. M. 143	T. B. M. 144	718	13.299	Direct	+ 131.7	− .50	− .23	+ .23	.33	7.4	1.5061					T.
				Reverse	+ 130.7	+ .50										
				Mean	+ 131.2											
T. B. M. 142	T. B. M. 143	663	13.962	Direct	− 416.3	− 1.35	− 1.58	+ 1.58	.90	7.5	1.0905					T.
				Reverse	− 419.0	+ 1.35										
				Mean	− 417.65											
T. B. M. 141	T. B. M. 142	745	14.707	Direct	+1,133.3	− .05	− 1.63	+ 1.63	.03	7.5	2.2287					W.
				Reverse	+1,133.2	+ .05										
				Mean	+1,133.25											
T. B. M. 140	T. B. M. 141	1,171	15.878	Direct	− 620.3	+ .40	− 1.23	+ 1.23	.27	7.5	1.6088					W.
				Reverse	− 619.5	− .40										
				Mean	− 619.9											

B. M. 2_{52}	T. B. M. 140	568	16.441	Direct	−1,577.8	− .35	− 1.58	+ 1.58	.28	7.5	.0267	0.084	σ 0.0301	− 18.4	−0.044	W.
				Reverse	−1,578.5	+ .35										
				Mean	−1,578.15											
Top of pipe over 2_{52}	B. M. 2_{52}	20	16.461	Direct	+1,193.0						1.2187	3.998				W.
T. B. M. 139	T. B. M. 140	548	16.426	Direct	+ 88.0	+ .50	− .78	+ .78	.33	7.5	1.6923					W.
				Reverse	+ 89.0	− .50										
				Mean	+ 88.5											
T. B. M. 138	T. B. M. 139	1,628	18.054	Direct	+ 876.0	− .15	− .88	+ .88	.10	7.5	2.0682					W.
				Reverse	+ 875.7	+ .15										
				Mean	+ 875.85											
T. B. M. 137	T. B. M. 138	1,146	19.200	Direct	− 55.8	+ .75	− .13	+ .13	.50	7.5	2.0131					W.
				Reverse	− 54.3	− .75										
				Mean	− 55.05											
T. B. M. 136	T. B. M. 137	1,151	20.351	Direct	− 168.0	+ .50	+ .37	− .37	.33	7.5	1.8456					T.
				Reverse	− 167.0	− .50										
				Mean	− 167.5											
T. B. M. 135	T. B. M. 136	1,438	21.789	Direct	+ 91.0	+ 1.35	+ 1.72	− 1.72	.90	7.6	1.9330					T.
				Reverse	+ 93.7	− 1.35										
				Mean	+ 92.35											
B. M. 2_{51}	T. B. M. 135	128	21.917	Direct	− 966.7	+ .20	+ 1.92	− 1.92	.13	7.6	.9715	3.187	σ .9495	+ 22.0	+ .072	T.
				Reverse	− 966.3	− .20										
				Mean	− 966.5											
Cap over B. M. 2_{51}	do	128	21.917	Direct	+ 242.0	.00	+ 1.72	− 1.72	.00	7.6	2.1800	7.152	σ 2.1611	+ 18.9	+ .062	T.
				Reverse	+ 242.0	.00										
				Mean	+ 242.0											
T. B. M. 134	T. B. M. 135	412	22.201	Direct	+ 172.0	+ .50	+ 2.22	− 2.22	.33	7.6	2.1105					T.
				Reverse	+ 173.0	− .50										
				Mean	+ 172.5											
T. B. M. 133	T. B. M. 134	863	23.064	Direct	+ 57.0	+ 1.15	+ 3.37	− 3.37	.77	7.6	2.1686					T.
				Reverse	+ 59.3	− 1.15										
				Mean	+ 58.15											

σ Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 132	T. B. M. 133	838	23.902	Direct	− 191.7	+ 1.20	+ 4.57	− 4.57	0.80	7.6	1.9781					T.
				Reverse	− 189.3	− 1.20										
				Mean	− 190.5											
T. B. M. 131	T. B. M. 132	710	24.612	Direct	− 432.3	+ .65	+ 5.22	− 5.22	.43	7.7	1.5465					T.
				Reverse	− 431.0	− .65										
				Mean	− 431.65											
T. B. M. 130	T. B. M. 131	899	25.011	Direct	+1,340.3	+ .20	+ 5.42	− 5.42	.13	7.7	2.8870					W.
				Reverse	+1,340.7	− .20										
				Mean	+1,340.5											
T. B. M. 129	T. B. M. 130	582	25.593	Direct	+ 24.5	− .30	+ 5.12	− 5.12	.20	7.7	2.9112					W.
				Reverse	+ 23.9	+ .30										
				Mean	+ 24.2											
B. M. 2_{1}^{28}	T. B. M. 129	15	25.608	Direct	− 928.8	− .10	+ 5.02	− 5.02	.07	7.7	1.9823	6.503	a 1.9227	+ 59.6	+0.196	W.
				Reverse	− 929.0	+ .10										
				Mean	− 928.9											
Cap over B. M. 2_{1}^{28}	T. B. M. 129	15	25.608	Direct	+ 269.5	− .15	+ 4.97	− 4.97	.10	7.7	3.1805	10.435	a 3.1312	+ 49.3	+ .162	W.
				Reverse	+ 269.2	+ .15										
				Mean	+ 269.35											
T. B. M. 128	T. B. M. 129	1,178	26.771	Direct	− 993.0	− 1.85	+ 3.27	− 3.27	1.23	7.8	1.9163					W.
				Reverse	− 996.7	+ 1.85										
				Mean	− 994.85											

T. B. M. 127	T. B. M. 128	1,064	27.885	First direct First reverse Second direct Second reverse	+1,607.5 +1,601.0 +1,608.5 +1,607.2	− 1.45 + 5.05 − 2.45 − 1.15	+ 1.82	− 1.82	1.15	7.8	3.5234					W.
				Mean	+1,606.05											
P. B. M. V; new position.	T. B. M. 127	941	28.776	Direct Reverse	+1,099.0 +1,095.3	− 1.85 + 1.85	− .58	+ .58	1.23	7.9	4.6195	15.156				W.
				Mean	+1,097.15											
T. B. M. 126	T. B. M. 127	523	28.358	Direct Reverse	− 869.8 − 870.3	− .25 + .25	+ 1.07	− 1.07	.17	7.8	2.6523					W.
				Mean	− 870.05											
T. B. M. 125	T. B. M. 126	889	29.197	Direct Reverse	− 432.3 − 430.3	+ 1.00 − 1.00	+ 2.07	− 2.07	.67	7.9	2.2210					T.
				Mean	− 431.3											
T. B. M. 124	T. B. M. 125	731	29.928	Direct Reverse	− 307.3 − 308.3	− .50 + .50	+ 1.57	− 1.57	.33	7.9	1.9132					T.
				Mean	− 307.8											
T. B. M. 123	T. B. M. 124	545	30.473	Direct Reverse	+ 21.3 + 20.7	− .30 + .30	+ 1.27	− 1.27	.20	7.9	1.9342					T.
				Mean	+ 21.0											
T. B. M. 122	T. B. M. 123	746	31.219	First direct First reverse Second direct Second reverse	+ 141.3 + 137.0 + 141.7 + 140.7	− 1.12 + 3.18 − 1.52 − .52	− .06	+ .06	.73	7.9	2.0744					T.
				Mean	+ 140.18											
T. B. M. 121	T. B. M. 122	860	32.079	Direct Reverse	− 484.3 − 484.3	.00 .00	− .06	+ .06	.00	7.9	1.5901					T.
				Mean	− 484.3											
T. B. M. 120	T. B. M. 121	859	32.938	Direct Reverse	− 78.3 − 82.0	− 1.85 + 1.85	− 1.91	+ 1.91	1.23	8.0	1.5160					T.
				Mean	− 80.15											

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. VI	T. B. M. 120	982	33.920	Direct	+2,668.5	− 0.75	− 2.66	+ 2.66	0.50	8.0	4.1777	13.706	4.1683	+ 9.4	+0.031	W.
				Reverse	+2,667.0	+ .75										
				Mean	+2,667.75											
B. M. $\frac{29}{4}$	T. B. M. 120	792	33.730	Direct	−1,032.2	− 1.30	− 3.21	+ 3.21	.87	8.1	.4765	1.563	a. 4438	+ 32.7	+ .107	W.
				Reverse	−1,034.8	+ 1.30										
				Mean	−1,033.5											
Cap over B. M. $\frac{29}{4}$	B. M. $\frac{29}{4}$	107	33.837	Direct	+1,206.3	+ .25	− 3.46	+ 3.46	.17	8.1	1.6880	5.521	a 1.6493	+ 33.7	+ .111	W.
				Reverse	+1,206.8	− .25										
				Mean	+1,206.55											
T. B. M. 119	B. M. $\frac{29}{4}$	898	34.628	Direct	+2,600.5	− .15	− 3.36	+ 3.36	.10	8.1	3.0768					W.
				Reverse	+2,600.2	+ .15										
				Mean	+2,600.35											
T. B. M. 118	T. B. M. 119	842	35.470	Direct	− 265.3	− .85	− 4.21	+ 4.21	.57	8.1	2.6107					W.
				Reverse	− 267.0	+ .85										
				Mean	− 266.15											
T. B. M. 117	T. B. M. 118	1,012	36.482	Direct	− 388.5	+ 1.35	− 2.86	+ 2.86	.90	8.1	2.4235					W.
				Reverse	− 385.8	− 1.35										
				Mean	− 387.15											
T. B. M. 116	T. B. M. 117	660	37.142	Direct	+ 35.0	+ .15	− 2.71	+ 2.71	.10	8.1	2.4587					W.
				Reverse	+ 35.3	− .15										
				Mean	+ 35.15											
T. B. M. 115	T. B. M. 116	774	37.916	Direct	− 291.5	− .35	− 3.06	+ 3.06	.23	8.1	2.1668					W.
				Reverse	− 292.2	+ .35										
				Mean	− 291.85											

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TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 105	T. B. M. 106	839	43.586	Direct	− 634.0	− 0.65	− 4.68	+ 4.68	0.43	8.2	8.5460					T.
				Reverse	− 635.3	+ .65										
				Mean	− 634.65											
T. B. M. 104	T. B. M. 105	860	44.446	Direct	+ 724.0	+ .85	− 3.83	+ 3.83	.57	8.2	4.2708					T.
				Reverse	+ 725.7	− .85										
				Mean	+ 724.85											
T. B. M. 102	T. B. M. 104	859	45.305	Direct	+ 332.7	+ 1.30	− 2.58	+ 2.58	.87	8.2	4.6043					T.
				Reverse	+ 335.3	− 1.30										
				Mean	+ 334.0											
T. B. M. 101	T. B. M. 102	1,662	46.967	Direct	− 226.8	+ 2.55	+ .02	− .02	1.70	8.4	4.3806					W.
				Reverse	− 221.7	− 2.55										
				Mean	− 224.25											
B. M. $\frac{2}{1}$	T. B. M. 101	604	47.561	Direct	− 197.2	+ .10	+ .12	− .12	.07	8.4	4.1335	13.725	a 4.1118	+71.7	+0.235	W.
				Reverse	− 197.0	− .10										
				Mean	− 197.1											
Cap over B. M. $\frac{2}{1}$	B. M. $\frac{2}{1}$	84	47.595	Direct	+1,207.8	+ .25	+ .37	− .37	.17	8.4	5.3915	17.689	a 5.3211	+70.4	+ .231	W.
				Reverse	+1,208.3	− .25										
				Mean	+1,208.05											
T. B. M. 100	T. B. M. 101	565	47.532	Direct	+ 511.2	− .35	− .33	+ .33	.23	8.4	4.8914					W.
				Reverse	+ 510.5	+ .35										
				Mean	+ 510.85											
T. B. M. 99	T. B. M. 100	1,656	49.188	Direct	− 623.4	+ .05	− .28	+ .28	.08	8.4	4.2681					W.
				Reverse	− 623.3	− .05										
				Mean	− 623.35											

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TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
Cap over B. M. 12[2] ...	B. M. 12[2]	17	56,912	Direct	+1,210.8	+ 0.20	+ 0.27	− 0.27	0.13	8.8	4.5782	15.004	a 4.4912	+ 82.0	+0.269	W.
				Reverse	+1,211.2	− .20										
				Mean....	+1,211.0											
T. B. M. 91	B. M. 12[2]	1.170	58.065	First direct....	− 887.5	+ 2.08	+ 1.39	− 1.39	.71	8.8	2.4768	.....	.....	.....	.....	W.
				First reverse...	− 882.5	− 2.92										
				Second direct..	− 886.0	+ .58										
				Second reverse.	− 885.7	+ .28										
				Mean....	− 885.42											
T. B. M. 90	T. B. M. 91	586	58.651	Direct	+ 409.7	− 1.50	− .11	+ .11	1.00	8.9	2.8850	.....	.....	.....	.....	T.
				Reverse	+ 406.7	+ 1.50										
				Mean....	+ 408.2											
T. B. M. 89	T. B. M. 90	859	59.510	Direct	− 236.7	+ .50	+ .39	− .39	.33	8.9	2.6488	.....	.....	.....	.....	T.
				Reverse	− 235.7	− .50										
				Mean....	− 236.2											
T. B. M. 88	T. B. M. 89	857	60.367	Direct	+ 82.3	+ 1.00	+ 1.39	− 1.39	.67	8.9	2.7321	.....	.....	.....	.....	T.
				Reverse	+ 84.3	− 1.00										
				Mean....	+ 83.3											
T. B. M. 87	T. B. M. 88	878	61.245	Direct	+ 260.7	− .20	+ 1.19	− 1.19	.13	8.9	2.9926	.....	.....	.....	.....	T.
				Reverse	+ 260.3	+ .20										
				Mean....	+ 260.5											
Ⓐ Chenet.....	T. B. M. 87	144	61.389	Direct	+ 246.7	+ .30	+ 1.49	− 1.49	.20	8.9	3.2396	10.628	.....	.....	.....	T.
				Reverse	+ 247.3	− .30										
				Mean....	+ 247.0											

T. B. M. 86	T. B. M. 87	869	62.114	Direct	+1,707.0	− .50	+ .59	− .59	33	8.9	4.6991					T.
				Reverse	+1,706.0	+ .50										
				Mean	+1,706.5											
P. B. M. X	T. B. M. 86	299	62.413	Direct	+ 860.8	− .80	+ .89	− .89	.20	8.9	5.5591	18.289	5.4726	+86.5	+ .284	T.
				Reverse	+ 859.7	+ .80										
				Mean	+ 860.0											
T. B. M. 85	T. B. M. 86	1,086	63.500	Direct	− 108.3	+ 2.80	+ 2.99	− 2.99	1.58	9.0	4.5981					W.
				Reverse	− 103.7	− 2.80										
				Mean	− 106.0											
T. B. M. 84	T. B. M. 85	1,223	64.723	Direct	− 471.3	+ 2.00	+ 4.99	− 4.99	1.33	9.1	4.1238					W.
				Reverse	− 467.3	− 2.00										
				Mean	− 469.3											
B. M. 1$\frac{91}{92}$	T. B. M. 84	498	65.221	Direct	−1,896.7	− .75	+ 4.24	− 4.24	.50	9.1	2.2264	7.304	a 2.1291	+97.3	+ .319	W.
				Reverse	−1,898.2	+ .75										
				Mean	−1,897.45											
Cap over B. M. 1$\frac{91}{92}$	B. M. 1$\frac{91}{92}$	21	65.242	Direct	+1,214.0	− .10	+ 4.14	− 4.14	.07	9.1	3.4406	11.287	a 3.3406	+99.7	+ .327	W.
				Reverse	+1,213.8	+ .10										
				Mean	+1,213.9											
T. B. M. 83	T. B. M. 84	2,011	66.734	Direct	− 95.7	+ .20	+ 5.19	− 5.19	.13	9.1	4.0283	13.216				W.
				Reverse	− 95.3	− .20										
				Mean	− 95.5											
T. B. M. 82	T. B. M. 83	1,237	67.971	Direct	− 221.7	− 1.00	+ 4.19	− 4.19	.67	9.2	3.8056					T.
				Reverse	− 223.7	+ 1.00										
				Mean	− 222.7											
T. B. M. 81	T. B. M. 82	1,005	68.976	Direct	+ 548.0	+ .35	+ 4.54	− 4.54	.23	9.2	4.3540					T.
				Reverse	+ 548.7	− .35										
				Mean	+ 548.35											
T. B. M. 80	T. B. M. 81	861	69.837	Direct	− 522.7	.00	+ 4.54	− 4.54	.00	9.2	3.8813					T.
				Reverse	− 522.7	.00										
				Mean	− 522.7											

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
B. M. $\frac{1}{2}$[a]	T. B. M. 80	84	69.921	Direct	− 608.8	0.00	+ 4.54	− 4.54	0.00	9.2	3.2225	10.572	a 3.1443	+ 78.2	+0.257	T.
				Reverse	− 608.8	.00										
				Mean	− 608.8											
Cap over B. M $\frac{1}{2}$[a]	T. B. M. 80	84	69.921	Direct	+ 603.9	− .35	+ 4.19	− 4.19	.28	9.2	4.4343	14.550	a 4.3559	+ 78.9	+ .259	T.
				Reverse	+ 603.2	+ .35										
				Mean	+ 603.55											
T. B. M. 79	T. B. M. 80	949	70.786	Direct	+1,867.7	− .85	+ 3.69	− 3.69	.57	9.2	5.6981					T.
				Reverse	+1,866.0	+ .85										
				Mean	+1,866.85											
T. B. M. 78	T. B. M. 79	880	71.666	Direct	− 836.3	+ .15	+ 3.84	− 3.84	.10	9.2	4.8620					T.
				Reverse	− 836.0	− .15										
				Mean	− 836.15											
T. B. M. 77	T. B. M. 78	993	72.659	Direct	− 300.3	+ .80	+ 4.64	− 4.64	.53	9.2	4.5625					T.
				Reverse	− 298.7	− .80										
				Mean	− 299.5											
T. B. M. 72	T. B. M. 77	1,811	73.970	Direct	− 32.2	− .90	+ 3.74	− 3.74	.60	9.2	4.5294					W.
				Reverse	− 34.0	+ .90										
				Mean	− 33.1											
B. M. $\frac{1}{2}$[a]	T. B. M. 72	135	74.105	Direct	−1,054.7	− .50	+ 3.24	− 3.24	.33	9.2	3.4742	11.398	a 3.4385	+ 35.7	+ .117	W.
				Reverse	−1,055.7	+ .50										
				Mean	−1,055.20											
Cap over B. M. $\frac{1}{2}$[a]	B. M. $\frac{1}{2}$[a]	49	74.154	Direct	+1,209.2	+ .15	+ 3.39	− 3.39	.10	9.2	4.6835	15.366	a 4.6470	+ 36.5	+ .120	W.
				Reverse	+1,209.5	− .15										
				Mean	+1,209.35											

T. B. M. 71	T. B. M. 72	1,136	76.106	Direct Reverse	+ 238.0 + 238.8	+ .40 - .40	+ 4.14	- 4.14	.27	9.2	4.7678	18.048				W.
				Mean	+ 238.4											
P. B. M. XII	T. B. M. 71	896	75.502	First direct First reverse Second direct. Second reverse.	+1,078.5 +1,082.2 +1,082.0 +1,081.8	+ 2.28 - 1.12 - .92 - .22	+ 4.81	- 4.81	.58	9.2	5.8488	19.189	5.8156	+ 33.2	+ .109	W.
				Mean	+1,081.06											
● Homestead	T. B. M. 71	1,248	76.854	Direct Reverse	+ 161.8 + 161.4	- .20 + .20	+ 3.94	- 3.94	.13	9.2	4.9294	16.172				W.
				Mean	+ 161.6											
T. B. M. 70	⊕ Homestead	1,225	77.579	Direct Reverse	-1,474.7 -1,475.3	- .30 + .30	+ 3.64	- 3.64	.20	9.2	3.4544					T.
				Mean	-1,475.0											
T. B. M. 69	T. B. M. 70	841	78.420	Direct Reverse	+ 335.7 + 339.3	+ 1.80 - 1.80	+ 5.44	- 5.44	1.20	9.3	3.7919					T.
				Mean	+ 337.5											
T. B. M. 65	T. B. M. 69	833	79.253	Direct Reverse	+ 102.0 + 101.7	- .15 + .15	+ 5.29	- 5.29	.10	9.3	3.8937					T.
				Mean	+ 101.85											
T. B. M. 66	T. B. M. 65	855	80.108	Direct Reverse	+1,967.7 +1,967.0	- .35 + .35	+ 4.94	- 4.94	.23	9.3	3.8611					T.
				Mean	+1,967.35											
P. B. M. XIV	T. B. M. 66	725	80.833	Direct Reverse	+1,425.3 +1,424.3	- .50 + .50	+ 4.44	- 4.44	.33	9.3	7.2859	23.904	7.2879	- 2.0	- .007	T.
				Mean	+1,424.8											
T. B. M. 67	P. B. M. XIV	2,836	83.169	Direct Reverse	-1,705.2 -1,708.7	- .25 + .25	+ 4.19	- 4.19	.17	9.3	5.5774					W.
				Mean	-1,708.45											
T. B. M. 68	T. B. M. 67	843	84.012	Direct Reverse	+ 933.5 + 931.7	- .90 + .90	+ 3.29	- 3.29	.60	9.3	6.4100					W.
				Mean	+ 932.6											

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. XIII	T. B. M. 68	28	84.040	Direct	+1,462.3	0.00	+ 3.29	− 3.29	0.00	9.3	7.8723	25.828	7.8759	− 3.6	−0.012	W.
				Reverse	+1,462.3	.00										
				Mean	+1,462.3											
T. B. M. 73	T. B. M. 68	865	84.877	First direct	+ 64.8	+ 3.02	+ 5.61	− 5.61	1.13	9.4	6.4778					W.
				First reverse	+ 72.5	− 4.68										
				Second direct	+ 66.2	+ 1.62										
				Second reverse	+ 67.8	+ .02										
				Mean	+ 57.82											
B. M. $\frac{1}{34}$	T. B. M. 73	17	84.894	Direct	−1,405.0	− .40	+ 5.21	− 5.21	.27	9.4	5.0724	16.642	a 5.0795	− 7.1	− .023	W.
				Reverse	−1,405.8	+ .40										
				Mean	−1,405.4											
Cap over B. M. $\frac{1}{34}$	T. B. M. 73	17	84.894	Direct	− 196.5	.00	+ 5.61	− 5.61	.00	9.4	6.2813	21.608	a 6.2871	− 5.8	− .019	W.
				Reverse	− 196.5	.00										
				Mean	− 196.5											
T. B. M. 74	T. B. M. 73	1,862	86.739	Direct	− 166.5	+ .15	+ 5.76	− 5.76	.10	9.4	6.3115					W.
				Reverse	− 166.2	− .15										
				Mean	− 166.35											
T. B. M. 75	T. B. M. 74	788	87.527	First direct	− 383.0	− 2.92	+ 4.18	− 4.18	.99	9.4	5.9256					T.
				First reverse	− 390.0	+ 4.08										
				Second direct	− 385.7	− .22										
				Second reverse	− 385.0	− .92										
				Mean	− 385.92											
T. B. M. 76	T. B. M. 75	856	88.383	Direct	+ 321.7	+ 1.80	+ 5.98	− 5.98	1.20	9.5	6.2491					T.
				Reverse	+ 325.3	− 1.80										
				Mean	+ 323.5											

[illegible] B. M. XII	T. B. M. 76	636	89.009	Direct Reverse	−400.8 −399.7	+.30 −.30	+ 6.28	6.98	.20	9.6	5.8491				
				Mean	−400.0										
T. B. M. 64	T. B. M. 65	1,576	80.829	Direct Reverse	+1,786.7 +1,786.0	−.35 +.35	+ 4.94	− 4.94	.23	9.8	5.6801				T.
				Mean	+1,786.35										
T. B. M. 63	T. B. M. 64	839	81.668	Direct Reverse	−1,208.7 −1,209.7	−.50 +.50	+ 4.44	− 4.44	.33	9.8	4.4709				T.
				Mean	−1,209.2										
T. B. M. 62	T. B. M. 63	966	82.606	Direct Reverse	− 58.7 − 57.8	+.70 −.70	+ 5.14	− 5.14	.47	9.8	4.4129				T.
				Mean	− 58.0										
B. M. 1[82]	T. B. M. 62	84	82.690	Direct Reverse	−1,161.3 −1,161.7	−.20 +.20	+ 4.94	− 4.94	.13	9.8	3.2514	10.667	a 3.2129	+ 38.5	+ .126	T.
				Mean	−1,161.5										
Cap over B. M. 1[82]	T. B. M. 62	84	82.690	Direct Reverse	+ 46.3 + 48.0	+.85 −.85	+ 5.99	− 5.99	.57	9.8	4.4600	14.688	a 4.4175	+ 42.5	+ .139	T.
				Mean	+ 47.15										
T. B. M. 61	T. B. M. 62	2,224	84.880	Direct Reverse	− 363.0 − 365.3	−1.15 +1.15	+ 3.99	− 3.99	.77	9.8	4.0457				T.
				Mean	− 364.15										
T. B. M. 60	T. B. M. 61	674	85.504	Direct Reverse	+ 889.0 + 888.8	−.10 +.10	+ 3.89	− 3.89	.07	9.8	4.9376				W.
				Mean	+ 888.9										
P. B. M. XV	T. B. M. 60	654	86.158	Direct Reverse	+2,196.3 +2,197.3	+.50 −.50	+ 4.39	− 4.89	.33	9.4	7.1344	23.407	7.0900	+ 44.4	+ .146	W.
				Mean	+2,196.8										
T. B. M. 59	T. B. M. 60	820	86.324	Direct Reverse	+ 308.2 + 309.0	+.40 −.40	+ 4.29	− 4.29	.27	9.4	5.2462				W.
				Mean	+ 308.6										

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897-98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897-98.	1897-98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 58	T. B. M. 59	2,324	88.648	Direct	+ 672.7	+ 0.65	+ 4.94	− 4.94	0.42	9.4	5.9196					T.
				Reverse	+ 674.0	− .65										
				Mean	+ 678.35											
B. M. $\frac{191}{1}$	T. B. M. 58	25	88.673	Direct	− 914.0	+ .15	+ 5.09	− 5.09	.10	9.4	5.0057	16.423	a 4.9838	+ 21.9	+0.072	T.
				Reverse	− 913.7	− .15										
				Mean	− 913.85											
Cap over B. M. $\frac{191}{1}$	T. B. M. 58	25	88.673	Direct	+ 292.0	+ .35	+ 5.29	− 5.29	.23	9.4	6.2119	20.380	a 6.1914	+ 20.5	+ .067	T.
				Reverse	+ 292.7	− .35										
				Mean	+ 292.35											
T. B. M. 57	T. B. M. 58	681	89.329	Direct	+ 14.8	− .40	+ 4.54	− 4.54	.27	9.4	5.9340					W.
				Reverse	− 14.0	+ .40										
				Mean	− 14.4											
T. B. M. 56	T. B. M. 57	336	90.165	Direct	− 58.8	− .10	+ 4.44	− 4.44	.07	9.4	5.8751					W.
				Reverse	− 59.0	+ .10										
				Mean	− 58.9											
T. B. M. 55	T. B. M. 56	709	90.874	Direct	− 483.7	− .30	+ 4.14	− 4.14	.20	9.4	5.3911					W.
				Reverse	− 484.3	+ .30										
				Mean	− 484.0											
B. M. $\frac{192}{2}$	T. B. M. 55	1,376	92.250	Direct	−2,131.3	+ .80	+ 4.94	− 4.94	.53	9.4	3.2606	10.697	a 3.2044	+ 56.2	+ .184	W.
				Reverse	−2,129.7	− .80										
				Mean	−2,130.5											
Cap over B. M. $\frac{192}{2}$	B. M. $\frac{192}{2}$	24	92.274	Direct	+1,208.0	− .15	+ 4.79	− 4.79	.10	9.4	4.4634	14.650	a 4.4169	+ 51.5	+ .169	W.
				Reverse	+1,207.7	+ .15										
				Mean	+1,207.85											

T. B. M. 56	B. M. 1[a]	820	93.070	Direct	+1,620.8	- 1.50	+ 3.44	- 3.44	1.00	9.4	4.8794				T.
				Reverse	+1,617.8	+ 1.50									
				Mean	+1,618.8										
T. B. M. 54	T. B. M. 53	940	94.010	Direct	+1,226.8	+ 1.50	+ 4.94	- 4.94	1.00	9.5	6.1072				T.
				Reverse	+1,229.8	- 1.50									
				Mean	+1,227.8										
P. R. M. XVI	T. B. M. 54	116	94.126	Direct	+1,449.0	- .35	+ 4.59	- 4.59 [a]	.23	9.5	7.5558	24.789	7.5164	+ 39.4	+ .129	T.
				Reverse	+1,448.3	+ .35									
				Mean	+1,448.65										
T. B. M. 52	T. B. M. 53	965	94.085	Direct	+ 57.3	+ 1.20	+ 4.64	- 4.64	.80	9.5	4.9879				T.
				Reverse	+ 59.7	- 1.20									
				Mean	+ 58.5										
T. B. M. 51	T. B. M. 52	752	94.787	First direct	- 666.7	+ 2.35	+ 7.14	- 7.14	1.15	9.5	4.2735				T.
				First reverse	- 659.7	- 4.65									
				Second direct	- 667.0	+ 2.65									
				Second reverse	- 664.0	- .35									
				Mean	- 664.35										
T. B. M. 50	T. B. M. 51	1,183	95.970	Direct	+2,007.7	+ .75	+ 7.89	- 7.89	.50	9.6	6.2820				W.
				Reverse	+2,009.2	- .75									
				Mean	+2,008.45										
T. B. M. 49	T. B. M. 50	330	96.300	Direct	+ 162.0	- .10	+ 7.79	- 7.79	.07	9.6	6.4439				W.
				Reverse	+ 161.8	+ .10									
				Mean	+ 161.9										
T. B. M. 48	T. B. M. 49	921	97.221	First direct	+ 168.2	+ 4.42	+10.31	-10.31	1.26	9.6	6.6165				W.
				First reverse	+ 177.3	- 4.68									
				Second direct	+ 172.0	+ .62									
				Second reverse	+ 173.0	- .38									
				Mean	+ 172.62										
T. B. M. 47	T. B. M. 48	805	98.026	Direct	- 410.2	.00	+10.31	-10.31	.00	9.6	6.2063				W.
				Reverse	- 410.2	.00									
				Mean	- 410.2										

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 45	T. B. M. 47	424	96.450	Direct	− 374.3	+ 0.80	+11.11	−11.11	0.53	9.6	5.8328					T.
				Reverse	− 372.7	− .80										
				Mean	− 373.5											
T. B. M. 46	T. B. M. 45	370	96.820	Direct	− 678.0	+ .35	+11.46	−11.46	.23	9.7	5.1551					T.
				Reverse	− 677.3	− .35										
				Mean	− 677.65											
B. M. 1[12]	T. B. M. 46	121	96.941	Direct	− 708.0	.00	+11.46	−11.46	.00	9.7	4.4471	14.590	a4.4585	− 11.4	−0.037	T.
				Reverse	− 708.0	.00										
				Mean	− 708.0											
Cap over B. M. 1[12]	T. B. M. 46	121	96.941	Direct	+ 501.7	+ .15	+11.61	−11.61	.10	9.7	5.6570	18.559	a5.6751	− 18.1	− .059	T.
				Reverse	+ 502.0	− .15										
				Mean	+ 501.85											
T. B. M. 44	T. B. M. 45	1,397	99.847	Direct	−1,639.0	+ .50	+11.61	−11.61	.33	9.7	4.1943					T.
				Reverse	−1,638.0	− .50										
				Mean	−1,638.5											
T. B. M. 43	T. B. M. 44	1,527	101.374	Direct	+ 281.0	+ 1.00	+12.61	−12.61	.67	9.7	4.4763					T.
				Reverse	+ 283.0	− 1.00										
				Mean	+ 282.0											
T. B. M. 42	T. B. M. 43	760	102.134	Direct	− 443.7	+ 1.85	+14.46	−14.46	1.23	9.8	4.0344					T.
				Reverse	− 440.0	− 1.85										
				Mean	− 441.85											
T. B. M. 41	T. B. M. 42	1,518	103.652	Direct	+1,011.8	+ 1.45	+15.91	−15.91	.97	9.8	5.0477					W.
				Reverse	+1,014.7	− 1.45										
				Mean	+1,013.25											

T. B. M. 40	T. B. M. 41	974	104.626	First direct	− 870.2	+ 5.35	+18.26	−18.26	1.35	9.9	4.6828					W.
				First reverse	− 864.5	− .35										
				Second direct	− 864.2	− .65										
				Second reverse	− 860.5	− 4.35										
				Mean	− 864.85											
T. B. M. 39	T. B. M. 40	570	105.196	Direct	+ 881.0	+ 1.40	+19.66	−19.66	.98	9.9	5.5652					W.
				Reverse	+ 883.8	− 1.40										
				Mean	+ 882.4											
T. B. M. 37	T. B. M. 39	860	106.056	Direct	+ 139.0	− 1.00	+18.66	−18.66	.67	10.0	5.7082					T.
				Reverse	+ 137.0	+ 1.00										
				Mean	+ 138.0											
T. B. M. 38	T. B. M. 37	607	106.663	Direct	+1,237.7	− .70	+17.96	−17.96	.47	10.0	6.9402					T.
				Reverse	+1,236.3	+ .70										
				Mean	+1,237.0											
B. M. $1\frac{1}{2}$a	T. B. M. 38	99	106.762	Direct	− 792.0	− .15	+17.81	−17.81	.10	10.0	6.1451	20.171	a 6.0968	+ 54.8	+ .120	T.
				Reverse	− 792.3	+ .15										
				Mean	− 792.15											
Top of pipe B. M. $1\frac{1}{2}$a	T. B. M. 38	99	106.762	Direct	+ 727.7	− .50	+17.46	−17.46	.33	10.0	7.6674	25.155				T.
				Reverse	+ 726.7	+ .50										
				Mean	+ 727.2											
T. B. M. 36	T. B. M. 37	622	106.678	Direct	+1,189.0	.00	+18.66	−18.66	.00	10.0	6.8922					T.
				Reverse	+1,189.0	.00										
				Mean	+1,189.0											
T. B. M. 35	T. B. M. 36	1,664	108.342	Direct	+ 513.1	− 1.90	+16.76	−16.76	1.27	10.0	7.4084					T.
				Reverse	+ 509.3	+ 1.90										
				Mean	+ 511.2											
T. B. M. 34	T. B. M. 35	777	109.119	Direct	− 533.6	− 1.55	+15.21	−15.21	1.08	10.1	6.8683					T.
				Reverse	− 536.7	+ 1.55										
				Mean	− 535.15											
P. B. M. New River	T. B. M. 34	29	109.148	Direct	− 639.7	− .15	+15.06	−15.06	.10	10.1	6.2284	20.434				W.
				Reverse	− 640.0	+ .15										
				Mean	− 639.85											

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
Cap over P. B. M. New River.	T. B. M. 34	29	109.148	Direct	+ 571.7	0.00	+15.21	−15.21	0.00	10.1	7.4400	24.410				W.
				Reverse	+ 571.7	.00										
				Mean	+ 571.7											
T. B. M. 33	T. B. M. 34	902	110.021	Direct	− 115.7	+ 1.35	+16.56	−16.56	.90	10.1	6.7589					W.
				Reverse	− 113.0	− 1.35										
				Mean	− 114.35											
T. B. M. 32	T. B. M. 33	814	110.835	Direct	− 537.5	− 1.10	+15.46	−15.46	.73	10.2	6.2153					W.
				Reverse	− 539.7	+ 1.10										
				Mean	− 538.6											
T. B. M. 31	T. B. M. 32	862	111.697	First direct	− 28.8	+ 4.42	+17.59	−17.59	1.06	10.2	6.1910					W.
				First reverse	− 21.5	− 2.88										
				Second direct	− 24.2	− .18										
				Second reverse	− 23.0	− 1.38										
				Mean	− 24.38											
T. B. M. 30	T. B. M. 31	458	112.150	Direct	+ 341.3	− .50	+17.09	−17.09	.33	10.2	6.5818					T.
				Reverse	+ 340.3	+ .50										
				Mean	+ 340.8											
P. B. M. XX	T. B. M. 30	454	112.604	Direct	+ 654.3	+ .20	+17.29	−17.29	.13	10.2	7.1868	23.577	7.1262	+ 60.1	+0.197	T.
				Reverse	+ 654.7	− .20										
				Mean	+ 654.5											
T. B. M. 29	T. B. M. 30	1,189	113.339	Direct	−1,108.3	− .50	+16.59	−16.59	.33	10.2	5.4230					T.
				Reverse	−1,109.3	+ .50										
				Mean	−1,108.8											

T. B. M. 28	T. B. M. 29	2,401	115.740	Direct Reverse	−1,006.0 −1,007.0	+ .50 + .50	+16.09	−16.09	.93	10.2	4.4105			T.
				Mean	−1,006.5									
T. B. M. 27	T. B. M. 28	883	116.623	Direct Reverse	+ 618.5 + 616.5	− 1.00 + 1.00	+15.09	−15.09	.67	10.3	5.0340			W.
				Mean	+ 617.5									
T. B. M. 26	T. B. M. 27	1,516	118.139	Direct Reverse	+1,008.7 +1,006.3	− 1.20 + 1.20	+13.89	−13.89	.80	10.3	6.0415			T.
				Mean	+1,007.5									
T. B. M. 25	T. B. M. 26	769	118.908	Direct Reverse	+ 312.3 + 310.7	− .80 + .80	+13.09	−13.09	.53	10.3	6.3530			T.
				Mean	+ 311.5									
P. B. M. St. Gabriel	T. B. M. 25	9	118.917	Direct Reverse	− 888.7 − 889.0	− .15 + .15	+12.94	−12.94	.10	10.3	5.4641	17.927		W.
				Mean	− 888.85									
Cap over P. B. M. St. Gabriel.	T. B. M. 25	9	118.917	Direct Reverse	+ 319.2 + 319.5	+ .15 − .15	+13.24	−13.24	.10	10.3	6.6723	21.891		W.
				Mean	+ 319.35									
T. B. M. 24	T. B. M. 25	1,075	119.983	First direct First reverse Second direct Second reverse	+ 188.3 + 195.7 + 188.2 + 191.8	+ 2.70 − 4.70 + 2.80 − .80	+15.84	−15.84	1.20	10.4	6.5440			W.
				Mean	+ 191.0									
T. B. M. 21	T. B. M. 24	759	120.742	Direct Reverse	− 463.3 − 460.7	+ 1.30 − 1.30	+17.14	−17.14	.87	10.4	6.0820			W.
				Mean	− 462.0									
T. B. M. 20	T. B. M. 21	738	121.480	Direct Reverse	− 772.2 − 775.3	− 1.55 + 1.55	+15.59	−15.59	1.03	10.5	5.3082			W.
				Mean	− 773.75									

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 22	T. B. M. 20	1,193	122.673	First direct	+2,464.5	− 4.48	+14.96	−14.96	1.09	10.5	7.7682	25.486				W.
				First reverse	+2,459.5	+ .52										
				Second direct	+2,456.8	+ 3.22										
				Second reverse	+2,459.3	+ .72										
				Mean	+2,460.02											
T. B. M. 23	T. B. M. 22	2,012	124.685	Direct	+ 179.7	− 2.20	+12.76	−12.76	1.47	10.6	7.9457					T.
				Reverse	+ 175.3	+ 2.20										
				Mean	+ 177.5											
P. B. M. XXIV	T. B. M. 23	2,441	127.126	Direct	− 16.3	− .65	+12.11	−12.11	.43	10.6	7.9288	26.013	7.8649	+ 63.9	+0.210	T.
				Reverse	− 17.6	+ .65										
				Mean	− 16.95											
B. M. 1[a]	P. B. M. XXIV	141	127.267	Direct	− 95.6	+ .15	+12.26	−12.26	.10	10.6	7.8333	25.700	a 7.7696	+ 63.7	+ .209	T.
				Reverse	− 95.3	− .15										
				Mean	− 95.45											
T. B. M. 19	T. B. M. 20	1,846	128.826	Direct	− 749.7	+ 1.60	+17.19	−17.19	1.07	10.5	4.5601					W.
				Reverse	− 746.5	− 1.60										
				Mean	− 748.1											
T. B. M. 18	T. B. M. 19	1,290	124.616	Direct	+1,077.5	+ 1.15	+18.34	−18.34	.77	10.5	5.6333					W.
				Reverse	+1,079.8	− 1.15										
				Mean	+1,078.65											
T. B. M. 17	T. B. M. 18	1,640	126.256	Direct	+1,872.7	+ .50	+18.84	−18.84	.83	10.5	7.5120					W.
				Reverse	+1,873.7	− .50										
				Mean	+1,873.2											

| | | |

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 5	T. B. M. 8	1,128	139.049	Direct	+ 62.7	0.00	+17.11	−17.11	0.00	10.7	7.5658					T.
				Reverse	+ 62.7	.00										
				Mean	+ 62.7											
T. B. M. 6	T. B. M. 5	759	139.808	Direct	+1,195.0	.00	+17.11	−17.11	.00	10.7	8.7608					T.
				Reverse	+1,195.0	.00										
				Mean	+1,195.0											
P. B. M. XXIX	T. B. M. 6	28	139.836	First direct	− 347.5	− .38	+16.73	−16.73	.16	10.7	8.4130	27.602	8.3634	+ 49.6	+0.163	T.
				First reverse	− 348.0	+ .12										
				Second direct	− 347.5	− .38										W.
				Second reverse	− 348.5	+ .62										
				Mean	− 347.88											
Cap over P. B. M. XXIX.	T. B. M. 6	28	139.836	Direct	+ 869.5	− .10	+17.01	−17.01	.07	10.7	9.6302	31.595				W.
				Reverse	+ 869.3	+ .10										
				Mean	+ 869.4											
T. B. M. 7	T. B. M. 6	1,283	141.091	Direct	− 323.7	+ 1.00	+18.11	−18.11	.67	10.7	8.4281					T.
				Reverse	− 321.7	− 1.00										
				Mean	− 322.7											
P. B. M. XXVIII	T. B. M. 7	1,835	142.926	Direct	+ 851.0	+ 1.00	+19.11	−19.11	.67	10.8	9.2901	30.479	9.1492	+140.9	+ .462	T.
				Reverse	+ 853.0	− 1.00										
				Mean	+ 852.0											
P. B. M. XXX	T. B. M. 5	1,525	140.574	Direct	+1,383.7	+ 1.00	+18.11	−18.11	.67	10.7	8.9505	29.365	a 8.7969	+153.6	+ .504	T.
				Reverse	+1,385.7	− 1.00										
				Mean	+1,384.7											

a Ordinary levels.

P. M. B. City Limits..	P. B. M. XXX ..	720	141.294	Direct	+ 365.0	— 1.06	+17.06	—17.06	.70	10.8	9.8146	50.560	.....	.....	.....	W.
				Reverse.....	+ 362.9	+ 1.06										
				Mean	+ 363.96											
B. M. 2 U. S. E.....	P. B. M. City Limits.	946	142.240	Direct	+1,154.8	+ .15	+17.21	—17.21	.10	10.8	10.4694	34.348	a10.8299	+139.5	+ .456	W.
				Reverse.....	+1,155.1	— .15										
				Mean	+1,154.95											
T. B. M. 1	B. M. 2 U. S. E ..	130	142.370	Direct	+7,944.7	+ .65	+17.86	—17.86	.43	10.8	18.4143	60.417	.....	.....	.....	W.
				Reverse.....	+7,946.0	— .65										
				Mean	+7,945.35											
P. B. M. XXXI.....	T. B. M. 1.....	26	142.396	Direct	+ 535.6	+ .05	+17.91	—17.91	.08	10.8	18.9504	62.173	18.8099	+140.5	+ .461	W.
				Reverse.....	+ 535.7	— .05										
				Mean	+ 535.65											
P. B. M. Barracks	T. B. M. 1.....	994	143.364	Direct	— 580.0	— 2.00	+15.86	—15.86	1.33	10.8	17.3328	56.907	.....	.....	.....	T.
				Reverse.....	— 584.0	+ 2.00										
				Mean	— 582.0											
T. B. M. 2.....	T. B. M. 1.....	201	142.571	Direct	—1,263.8	— .35	+17.51	—17.51	.23	10.8	17.1506	56.269	.....	.....	.....	W.
				Reverse.....	—1,264.5	+ .35										
				Mean	—1,264.15											
P. B. M. post-office ...	T. B. M. 2.....	67	142.638	Direct	+ 857.3	— .15	+17.36	—17.36	.10	10.8	18.0078	59.061	.....	.....	.....	W.
				Reverse.....	+ 857.0	+ .15										
				Mean	+ 857.15											
P. B. M. North Boulevard.	T. B. M. 2.....	69	142.640	Direct	—1,285.2	— .25	+17.26	—17.26	.17	10.8	15.8362	52.002	.....	.....	.....	W.
				Reverse.....	—1,285.7	+ .25										
				Mean	—1,285.45											
Cap over P. B. M. North Boulevard.	T. B. M. 2.....	69	142.640	Direct	— 81.8	+ .05	+17.56	—17.56	.08	10.8	17.0889	56.001	.....	.....	.....	W.
				Reverse.....	— 81.7	— .05										
				Mean	— 81.75											
T. B. M. 3.....	B. M. 2 U. S. E ..	156	142.396	Direct	— 841.8	+ .25	+17.46	—17.46	.17	10.8	9.6279	.....	.....	.....	.....	W.
				Reverse.....	— 841.3	— .25										
				Mean	— 841.55											

a Ordinary levels.

TABLE No. 9.—*Tabulation of precise-level results from New Orleans, La., to Baton Rouge, La., 1897–98*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1897–98.	1897–98.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 4, river crossing at Baton Rouge.	T. B. M. 3.....	860	142.256	First direct....	+ 14.9	+ 8.48	+17.14	−17.14	0.85	10.8	9.6513	.....	.....	.....	.....	W. and T.
				First reverse...	+ 20.0	+ 8.38										
				Second direct .	+ 20.9	+ 2.48										
				Second reverse.	+ 23.9	− .52										
				Third direct...	+ 27.4	− 4.02										
				Third reverse..	+ 22.6	+ .78										
				Fourth direct .	+ 30.1	− 6.72										
				Fourth reverse.	+ 28.3	− 4.92										
				Fifth direct....	+ 26.5	− 3.12										
				Fifth reverse ..	+ 19.0	+ 4.38										
				Sixth direct ...	+ 22.4	+ .98										
				Sixth reverse..	+ 24.6	− 1.22										
				Mean	+ 23.38											
P. B. M. XXXII.....	T. B. M. 4.....	397	143.653	Direct	−1,026.7	+ .10	+17.24	−17.24	.07	10.8	8.6247	28.296	8.4633	+161.4	+0.530	W.
				Reverse.....	−1,026.5	− .10										
				Mean	−1,026.6											

NOTE.—Probable error for kilometer = ±0.68 millimeter.

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Port Adams, Miss., 1900.*

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
P. B. M. XXXII										10.8	8.6247	28.296	8.4693	+161.4	+0.530	W.
T. B. M. 91	P. B. M. XXXII	544	0.544	Direct	+ 760.5	+ 0.50	+ 0.50	− 0.50	0.33	10.8	9.3957					
				Reverse	+ 761.5	− .50										
				Mean	+ 761.0											
T. B. M. 90	T. B. M. 91	1,554	2.098	Direct	− 614.2	− .40	+ .10	− .10	.27	10.8	8.7711	28.777				W.
				Reverse	− 615.0	+ .40										
				Mean	− 614.6											
T. B. M. 89	T. B. M. 90	1,918	4.016	Direct	+ 619.0	− 1.25	− 1.15	+ 1.15	.38	10.8	9.3886	30.806				W.
				Reverse	+ 616.5	+ 1.25										
				Mean	+ 617.75											
T. B. M. 88	T. B. M. 89	1,101	5.117	Direct	+ 52.5	− .85	− 2.00	+ 2.00	.57	10.8	9.4405	30.973				W.
				Reverse	+ 50.8	+ .85										
				Mean	+ 51.65											
B. M. 4[2]	T. B. M. 88	109	5.226	Direct	+ 487.8	− .15	− 2.15	+ 2.15	.10	10.8	9.9282	32.573	a 9.7505	+177.7	+ .583	H.
				Reverse	+ 487.5	+ .15										
				Mean	+ 487.65											
P. B. M., Poplar Grove	T. B. M. 88	65	5.182	Direct	− 838.8	− .45	− 2.45	+ 2.45	.30	10.8	8.6012	28.219				H.
				Reverse	− 839.7	+ .45										
				Mean	− 839.25											
Cap of P. B. M., Poplar Grove.	T. B. M. 88	65	5.182	Direct	+ 376.2	+ .75	− 1.25	+ 1.25	.50	10.9	9.5174	32.210				H.
				Reverse	+ 377.7	− .75										
				Mean	+ 376.95											

a Ordinary levels.

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 87	T. B. M. 88	962	6.079	Direct	+ 48.7	− 1.10	− 8.10	+ 8.10	0.78	10.9	9.4881	31.129				H.
				Reverse	+ 46.5	+ 1.10										
				Mean	+ 47.6											
T. B. M. 86	T. B. M. 87	1,168	7.247	Direct	− 96.8	+ 1.75	− 1.35	+ 1.35	1.17	10.9	9.3980					H.
				Reverse	− 93.3	− 1.75										
				Mean	− 95.05											
T. B. M. 85	T. B. M. 86	610	7.857	First direct	− 169.2	+ .50	+ .65	− .65	.97	11.0	9.2244	30.264				H.
				First reverse	− 165.2	− 3.50										
				Second direct	− 172.2	+ 3.50										
				Second reverse	− 168.2	− .50										
				Mean	− 168.7											
T. B. M. 84	T. B. M. 85	1,557	9.414	Direct	+ 36.0	+ .85	+ 1.50	− 1.50	.57	11.0	9.2612	30.385				W.
				Reverse	+ 37.7	− .85										
				Mean	+ 36.85											
B. M. 14[2]	T. B. M. 84	1,067	10.481	Direct	−1,790.3	+ .15	+ 1.65	− 1.65	.10	11.0	7.4710	24.511	a 7.2816	+189.4	+0.621	W.
				Reverse	−1,790.0	− .15										
				Mean	−1,790.15											
Cap of B. M. 14[2]	B. M. 14[2]	181	10.612	Direct	+1,545.8	+ .85	+ 2.00	− 2.00	.23	11.0	9.0172	29.584				W.
				Reverse	+1,546.5	− .85										
				Mean	+1,546.15											
P. B. M. XXXIII	T. B. M. 84	1,687	11.101	Direct	+ 73.0	− 1.15	+ .35	− .35	.77	11.0	9.3330	30.620	9.1501	+182.9	+ .600	W.
				Reverse	+ 70.7	+ 1.15										
				Mean	+ 71.85											

T. B. M. 83	P. B. M. XXXIII	788	11.834	Direct	+ 852.2	+ 852.7	+ .80	+ .05	− .05	.20	11.0	8.9940	29.811					H.
				Reverse	+ 851.7														
				Mean		+ 852.0													
T. B. M. 82	T. B. M. 83	1,068	12.917	Direct		− 752.0	+ 1.00	+ 1.05	− 1.05	.67								H.	
				Reverse		− 750.0	− 1.00												
				Mean		− 751.0													
T. B. M. 81	T. B. M. 82	1,508	14.420	Direct		− 831.8	+ 1.75	+ 2.80	− 2.80	1.17	11.1	8.1040						H.	
				Reverse		− 828.3	− 1.75												
				Mean		− 830.05													
T. B. M. 80	T. B. M. 81	672	14.922	Direct		+ 216.3	− 1.50	+ 1.80	− 1.80	1.00	11.1	8.0188	27.208					H.	
				Reverse		+ 213.8	+ 1.50												
				Mean		+ 214.8													
P. B. M., Allendale	T. B. M. 80	42	15.084	Direct		− 537.2	+ .10	+ 1.40	− 1.40	.07	11.1	7.7617	25.531					H.	
				Reverse		− 537.0	− .10												
				Mean		− 537.1													
Cap of P. B. M., Allendale.	T. B. M. 80	42	15.084	Direct		+ 672.8	.00	+ 1.80	− 1.80	.00	11.1	8.9916	29.600					H.	
				Reverse		+ 672.8	.00												
				Mean		+ 672.8													
T. B. M. 79	T. B. M. 80	1,880	16.822	Direct		+ 562.8	+ 1.10	+ 2.40	− 2.40	.78	11.2	8.8827						H.	
				Reverse		+ 566.0	− 1.10												
				Mean		+ 563.9													
T. B. M. 78	T. B. M. 79	854	17.176	Direct		− 1 460.7	− .25	+ 2.15	− 2.15	.17	11.2	7.4218						H.	
				Reverse		− 1 461.2	+ .25												
				Mean		− 1, 460.95													
T. B. M. 77	T. B. M. 78	1,469	18.645	Direct		+ 1, 631.0	− 1.65	+ .50	− .50	1.10	11.2	9.0611						W.	
				Reverse		+ 1, 627.7	+ 1.65												
				Mean		+ 1, 629.85													
P. B. M. XXXIV	T. B. M. 77	1,831	19.976	Direct		+ 511.7	− .85	− .85	+ .85	.57	11.2	9.5620	31.672	9.4040	+156.0	+ .518		W.	
				Reverse		+ 510.0	+ .85												
				Mean		+ 510.85													

a Ordinary levels.

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 76	P. B. M. XXXIV	1,855	21.881	Direct	+ 701.8	+ 0.60	+ 0.25	− 0.25	0.40	11.2	10.2644					W.
				Reverse	+ 708.0	− .60										
				Mean	+ 702.4											
T. B. M. 75	T. B. M. 76	889	22.720	Direct	− 119.5	− 1.60	− 1.35	+ 1.35	1.07	11.3	10.1432	33.279				W.
				Reverse	− 122.7	+ 1.60										
				Mean	− 121.1											
T. B. M. 74	T. B. M. 75	1,409	24.129	Direct	− 184.0	+ 1.65	+ .30	− .30	1.10	11.3	9.9609	32.680				H.
				Reverse	− 180.7	− 1.65										
				Mean	− 182.35											
P. B. M., Solitude	T. B. M. 74	18	24.147	Direct	− 968.3	+ .30	+ .60	− .60	.20	11.3	8.9929	29.504				H.
				Reverse	− 967.7	− .30										
				Mean	− 968.0											
Cap of P. B. M., Solitude.	T. B. M. 74	18	24.147	Direct	+ 235.3	− .15	+ .15	− .15	.10	11.3	10.1960	33.452				H.
				Reverse	+ 235.0	+ .15										
				Mean	+ 235.15											
T. B. M. 73	T. B. M. 74	258	24.387	Direct	− 65.5	− .25	+ .05	− .05	.17	11.3	9.8952	32.465				H.
				Reverse	− 66.0	+ .25										
				Mean	− 65.75											
T. B. M. 72	T. B. M. 73	1,447	25.834	Direct	− 610.2	+ 1.60	+ 1.65	− 1.65	1.07	11.4	9.2866	30.468				H.
				Reverse	− 607.0	− 1.60										
				Mean	− 608.6											
T. B. M. 71	T. B. M. 72	1,485	27.319	Direct	+ 426.5	+ .60	+ 2.25	− 2.25	.40	11.4	9.7136					H
				Reverse	+ 427.7	− .60										
				Mean	+ 427.1											

T. B. M. 70	T. B. M. 71	391	27.710	Direct	− 308.2	− .50	+ 1.75	− 1.75	.88	11.4	9.4050	30.857				H.
				Reverse	− 309.2	+ .50										
				Mean	− 308.7											
T. B. M. 69	T. B. M. 70	1,820	29.580	Direct	+ 371.3	+ 2.60	+ 4.35	− 4.35	1.73	11.5	9.7769					W.
				Reverse	+ 376.5	− 2.60										
				Mean	+ 373.9											
B. M. 1[st]	T. B. M. 69	571	30.101	Direct	− 541.8	+ .75	+ 5.10	− 5.10	.50	11.5	9.2878	30.808	a 9.1104	+127.4	+0.418	W.
				Reverse	− 540.3	− .75										
				Mean	− 541.05											
T. B. M. 68	T. B. M. 69	1,749	31.279	Direct	− 239.3	+ 1.65	+ 6.00	− 6.00	1.10	11.6	9.5412					W.
				Reverse	− 236.0	− 1.65										
				Mean	− 237.65											
P. B. M. XXXV	T. B. M. 68	885	32.164	First direct	+ 965.0	+ 2.80	+ 6.45	− 6.45	.86	11.6	10.5085	34.477	10.3068	+204.7	+ .672	W.
				First reverse	+ 970.3	− 3.00										
				Second direct	+ 968.7	− 1.40										
				Second reverse	+ 965.2	+ 2.10										
				Mean	+ 967.8											
T. B. M. 67	P. B. M. XXXV	485	32.649	Direct	+3,684.5	+ .60	+ 7.05	− 7.05	.40	11.6	14.1966					H.
				Reverse	+3,685.7	− .60										
				Mean	+3,685.1											
T. B. M. 66	T. B. M. 67	780	33.379	Direct	− 61.7	+ 1.80	+ 8.85	− 8.85	.98	11.7	14.1337					H.
				First reverse	− 57.2	− 2.70										
				Second reverse	− 60.8	+ .90										
				Mean	− 59.9											
T. B. M. 65	T. B. M. 66	1,065	34.444	Direct	−3,046.3	+ .25	+ 9.10	− 9.10	.17	11.7	11.0876	36.877				H.
				Reverse	−3,045.8	− .25										
				Mean	−3,046.05											
B. M. 1[st]	T. B. M. 65	931	35.375	Direct	+ 70.2	+ .75	+ 9.85	− 9.85	.50	11.7	11.1586	36.610	a 10.9087	+249.9	+ .820	H.
				Reverse	+ 71.7	− .75										
				Mean	+ 70.95											

a Ordinary levels.

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 64	B. M. 14A	2,672	38.047	Direct	− 863.3	− 0.60	+ 9.25	− 9.25	0.40	11.7	10.2947	33.776				W.
				Reverse	− 864.5	+ .60										
				Mean	− 863.9											
P. B. M. XXXVI	T. B. M. 64	1,418	39.465	Direct	+1,230.8	+ .20	+ 9.45	− 9.45	.13	11.7	11.5257	37.814	11.2592	+266.5	+ .874	W.
				Reverse	+1,231.2	− .20										
				Mean	+1,231.0											
T. B. M. 63	P. B. M. XXXVI.	1,799	41.264	Direct	− 829.7	− .40	+ 9.05	− 9.05	.27	11.7	10.6956	35.091				W.
				Reverse	− 830.5	+ .40										
				Mean	− 830.1											
T. B. M. 62	T. B. M. 63	1,058	42.322	Direct	+ 414.2	+ .65	+ 9.70	− 9.70	.43	11.7	11.1104					H.
				Reverse	+ 415.5	− .65										
				Mean	+ 414.85											
T. B. M. 61	T. B. M. 62	1,368	43.685	Direct	+ 462.5	+ 1.15	+10.85	−10.85	.77	11.7	11.5741	37.978				H.
				Reverse	+ 464.8	− 1.15										
				Mean	+ 463.65											
B. M. 13	T. B. M. 61	46	43.731	Direct	− 42.7	.00	+10.85	−10.85	.00	11.7	11.5314	37.838				H.
				Reverse	− 42.7	.00										
				Mean	− 42.7											
T. B. M. 60	T. B. M. 61	909	44.594	Direct	+ 504.8	+ .85	+11.70	−11.70	.57	11.7	12.0798					H.
				Reverse	+ 506.5	− .85										
				Mean	+ 505.65											
P. B. M. XXXVII	T. B. M. 60	0	44.594	Direct	+1,651.0		+11.70	−11.70		11.7	13.7308	45.049	13.4954	+235.4	+0.772	H.

T. B. M. 59	T. B. M. 60	1,176	45.770	Direct													H.
				Reverse													
				Mean													
T. B. M. 58	T. B. M. 59	1,095	46.865	Direct	+ 199.7	+ .65	+11.40	−11.40	.43	11.8	11.8384	38.840					W.
				Reverse	+ 201.0	− .65											
				Mean	+ 200.35												
T. B. M. 57	T. B. M. 58	1,857	48.222	Direct	+ 345.5	+ 1.35	+12.75	−12.75	.90	11.8	12.1882	39.966					W.
				Reverse	+ 351.2	− 1.35											
				Mean	+ 349.85												
T. B. M. 56	T. B. M. 57	1,810	49,532	Direct	− 285.0	+ 1.00	+13.75	−13.75	.67	11.8	11.9042	39.056					W.
				Reverse	− 283.0	− 1.00											
				Mean	− 284.0												
P. B. M. XXXVIII	T. B. M. 56	1,546	51,078	Direct	+ 139.2	+ 1.05	+14.80	−14.80	.70	11.8	12.0444	39.516	11.7774	+267.0	+ .876	W.	
				Reverse	+ 141.3	− 1.05											
				Mean	+ 140.25												
T. B. M. 55	P. B. M. XXXVIII.	765	51.843	Direct	+ 179.3	− .90	+13.90	−13.90	.60	11.8	12.2228	40.101					H.
				Reverse	+ 177.5	+ .90											
				Mean	+ 178.4												
P. B. M. XXXIX	T. B. M. 55	754	52.597	Direct	− 273.7	+ .70	+14.60	−14.60	.47	11.9	11.9498	39.206	11.6442	+305.6	+1.008	H.	
				Reverse	− 272.3	− .70											
				Mean	− 273.0												
B. M. 1[82]	P. B. M. XXXIX	772	53.369	Direct	− 341.2	.00	+14.60	−14.60	.00	11.9	11.6086	38.086	a11.3354	+273.2	+ .896	H.	
				Reverse	− 341.2	.00											
				Mean	− 341.2												
T. B. M. 54	B. M. 1[82]	1,430	54.799	Direct	+ 47.2	+ .50	+15.10	−15.10	.33	11.9	11.6564					H.	
				Reverse	+ 48.2	− .50											
				Mean	+ 47.7												
T. B. M. 53	T. B. M. 54	1,459	56.258	Direct	−1,849.7	+ 1.85	+16.95	−16.95	1.28	11.9	9.8085	32.180					H.
				Reverse	−1,846.0	− 1.85											
				Mean	−1,847.85												

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 52	T. B. M. 58	1,602	57.860	Direct	+ 764.0	+ 1.15	+18.10	−18.10	0.77	11.9	10.5736					W.
				Reverse	+ 766.3	− 1.15										
				Mean	+ 765.15											
T. B. M. 51	T. B. M. 52	1,327	59.187	Direct	+ 304.5	.00	+18.10	−18.10	.00	11.9	10.5782					W.
				Reverse	+ 304.5	.00										
				Mean	+ 304.5											
B. M. 14[a]	T. B. M. 51	274	59.461	Direct	−1,418.7	+ .35	+18.45	−18.45	.23	11.9	9.4596	31.066	a 9.2019	+257.9	+0.846	W.
				Reverse	−1,418.0	− .35										
				Mean	−1,418.35											
Top of pipe over B. M. 14[a]	B. M. 14[a]	74	59.535	Direct	+1,522.8	+ .20	+18.65	−18.65	.13	11.9	10.9828	36.033				W.
				Reverse	+1,523.2	− .20										
				Mean	+1,523.0											
P. B. M. XL	T. B. M. 51	1,330	60.517	Direct	+ 496.2	− .25	+17.85	−17.85	.17	11.9	11.3741	37.317	11.1251	+249.0	+ .817	W.
				Reverse	+ 495.7	+ .25										
				Mean	+ 495.95											
T. B. M. 50	P. B. M. XL	1,427	61.944	Direct	+ 747.7	− .45	+17.40	−17.40	.30	12.0	12.1214	39.769				W.
				Reverse	+ 746.8	+ .45										
				Mean	+ 747.25											
T. B. M. 49	T. B. M. 50	2,333	64.277	Direct	+ 288.0	− .15	+17.25	−17.25	.10	12.0	12.3592	40.549				H.
				Reverse	+ 287.7	+ .15										
				Mean	+ 287.85											
T. B. M. 48	T. B. M. 49	1,026	65.308	Direct	+ 15.7	+ 1.90	+19.15	−19.15	1.27	12.0	12.3768					H.
				Reverse	+ 19.5	− 1.90										
				Mean	+ 17.6											

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±	R ±	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 40	T. B. M. 41	611	77.646	First direct	+ 357.2	− 1.43	+19.08	−19.08	0.69	12.2	15.6480	51.323				H.
				Reverse	+ 353.8	+ 1.97										
				Second direct	+ 356.3	− .53										
				Mean	+ 355.77											
T. B. M. 39	T. B. M. 40	1,462	79.108	Direct	−5,035.2	+ 1.10	+20.18	−20.18	.78	12.2	10.6069	34.806				W.
				Reverse	−5,033.0	− 1.10										
				Mean	−5,034.1											
B. M. 1[18]	T. B. M. 39	265	79.373	Direct	− 744.5	− .10	+20.08	−20.08	.07	12.2	9.8643	32.363	a9.6286	+235.7	+0.773	W.
				Reverse	− 744.7	+ .10										
				Mean	− 744.6											
T. B. M. 38	T. B. M. 39	1,077	80.185	Direct	+ 876.7	− .45	+19.73	−19.73	.30	12.3	11.4851	37.681				W.
				Reverse	+ 875.8	+ .45										
				Mean	+ 876.25											
T. B. M. 37	T. B. M. 38	1,035	81.220	Direct	+ 563.7	+ .30	+20.08	−20.08	.20	12.3	12.0491	39.532				W.
				Reverse	+ 564.3	− .30										
				Mean	+ 564.0											
P. B. M. XLIII	T. B. M. 37	59	81.279	Direct	− 220.3	− .20	+19.83	−19.83	.13	12.3	11.8286	38.806	11.5978	+230.8	+ .757	W.
				Reverse	− 220.7	+ .20										
				Mean	− 220.5											
T. B. M. 36	T. B. M. 37	1,627	82.857	Direct	+4,386.2	+ .50	+20.58	−20.58	.33	12.3	16.4358					W.
				Reverse	+4,387.2	− .50										
				Mean	+4,386.7											

T. B. M. 35	T. B. M. 36	1,503	84.210	Direct Reverse	[illegible] [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	W.
				Mean	−456.0										
T. B. M. 34	T. B. M. 35	1,584	85.794	Direct Reverse	+ 593.2 + 591.2	− 1.00 + 1.00	+20.33	−20.33	.67	12.8	16.5720				W.
				Mean	+ 592.2										
T. B. M. 33	T. B. M. 34	1,961	87.755	Direct Reverse	−2,246.8 −2,246.8	.00 .00	+20.33	−20.33	.00	12.8	14.3252	46.999			W.
				Mean	−2,246.8										
T. B. M. 32	T. B. M. 33	1,442	89.197	Direct Reverse	+2,153.8 +2,152.2	− .80 + .80	+19.53	−19.53	.53	12.8	16.4782				W.
				Mean	+2,153.0										
T. B. M. 31	T. B. M. 32	1,075	90.272	Direct Reverse	+ 41.8 + 44.8	+ 1.50 − 1.50	+21.08	−21.08	1.00	12.8	16.5215				W.
				Mean	+ 43.3										
T. B. M. 30	T. B. M. 31	1,301	91.573	Direct Reverse	+ 373.6 + 371.3	− 1.15 + 1.15	+19.88	−19.88	.77	12.4	16.8040				H.
				Mean	+ 372.45										
T. B. M. 29	T. B. M. 30	909	92.482	Direct Reverse	+ 158.3 + 157.2	− .55 + .55	+19.33	−19.33	.37	12.4	17.0517				H.
				Mean	+ 157.75										
T. B. M. 28	T. B. M. 29	433	92.915	First direct First reverse Second direct Second reverse	+ 163.5 + 167.2 + 163.7 + 162.5	+ .72 − 2.98 + .52 + 1.72	+19.95	−19.95	.69	12.4	17.2159				H.
				Mean	+ 164.22										
T. B. M. 27	T. B. M. 28	839	93.754	Direct Reverse	− 292.7 − 289.3	+ 1.70 − 1.70	+21.65	−21.65	1.13	12.4	16.9249				H.
				Mean	− 291.0										
T. B. M. 26	T. B. M. 27	945	94.699	Direct Reverse	+ 37.3 + 37.3	.00 .00	+21.65	−21.65	.00	12.4	16.9622				H.
				Mean	+ 37.3										

a Ordinary levels.

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V.		r ±.	R ±.	Elevation above mean Gulf level.			Discrepancy.		Observer.
							Direct line.	Reverse line.			1900.	1900.	Former elevation.			
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
T. B. M. 25	T. B. M. 26	714	95.413	Direct	+ 34.8	+ 0.20	+21.85	−21.85	0.13	12.4	16.9972					H.
				Reverse	+ 35.2	− .20										
				Mean	+ 35.0											
T. B. M. 24	T. B. M. 25	690	96.103	Direct	−2,431.0	+ 1.63	+23.48	−23.48	.88	12.5	14.5679					H.
				First reverse	−2,426.8	− 2.57										
				Second reverse	−2,430.3	+ .93										
				Mean	−2,429.37											
P. B. M. XLIV	T. B. M. 24	227	96.330	Direct	− 838.7	− .55	+22.93	−22.93	.87	12.5	13.7286	45.042	13.5289	+199.7	+0.655	H.
				Reverse	− 839.8	+ .55										
				Mean	− 839.25											
T. B. M. 23	T. B. M. 24	1,664	97.767	Direct	+2,811.8	+ .95	+24.43	−24.43	.63	12.5	17.3806					W.
				Reverse	+2,813.7	− .95										
				Mean	+2,812.75											
T. B. M. 22	T. B. M. 23	1,852	99.619	Direct	−2,479.5	− 1.65	+22.78	−22.78	1.10	12.5	14.8995	48.883				W.
				Reverse	−2,482.8	+ 1.65										
				Mean	+2,481.15											
T. B. M. 21	T. B. M. 22	1,742	101.361	Direct	+ 1.2	− .25	+22.53	−22.53	.17	12.5	14.9004					W.
				Reverse	+ .7	+ .25										
				Mean	+ .95											
T. B. M. 20	T. B. M. 21	1,881	103.242	Direct	+ 221.2	+ .25	+22.78	−22.78	.17	12.5	15.1219	49.613				W.
				Reverse	+ 221.7	− .25										
				Mean	+ 221.45											

T. B. M. 19	T. B. M. 20.....	712	103.664	Direct	+ 118.8	.00	+23.78	-23.78	.61	12.6	13.2402				H.
				Reverse	+ 118.8										
				Mean....	+ 118.8										
P. B. M., Smithland; bolt in tile.	T. B. M. 19.....	836	104.290	Direct	1,796.3	+ .75	+23.53	-23.53	.50	12.6	13.4481	44.112	.....	.....	H.
				Reverse	−1,794.8	− .75									
				Mean....	−1,795.55										
Cap of P. B. M., Smithland.	P. B. M., Smithland.	31	104.321	Direct	+1,212.7	+ .55	+24.08	−24.08	.37	12.6	14.6584	48.092	.....	.....	H.
				Reverse	+1,213.8	− .55									
				Mean....	+1,213.25										
P. B. M. XLV	T. B. M. 19.....	446	104.400	Direct	− 417.3	+ .05	+22.83	−22.83	.03	12.5	14.8234	48.634	14.6011	+222.3	+ .729	H.
				Reverse	− 417.2	− .05									
				Mean....	− 417.25										
T. B. M. 18	T. B. M. 19.....	325	104.279	Direct	−1,260.8	+ 1.15	+23.93	−23.93	.77	12.6	13.9810	.....	.....	.....	.....	H.
				Reverse	−1,258.5	− 1.15									
				Mean....	−1,259.65										
T. B. M. 17	T. B. M. 18... ..	1,252	105.531	Direct	+ 412.8	+ 1.85	+25.78	−25.78	1.23	12.6	14.3967	47.230	.....	.....	.....	H.
				Reverse	+ 416.5	− 1.85									
				Mean....	+ 414.65										
T. B. M. 16	T. B. M. 17.....	855	106.386	Direct	−1,602.2	+ .85	+26.63	-26.63	.57	12.6	12.7943	.....	.....	.....	.....	H.
				Reverse	−1,600.5	− .85									
				Mean....	−1,601.35										
T. B. M. 15	T. B. M. 16.....	550	106.936	First direct	+ 117.5	+ 2.63	+29.49	−29.49	1.07	12.7	12.9144	.....	.....	.....	.....	H.
				Reverse	+ 123.0	− 2.87									
				Second direct..	+ 119.9	+ .23									
				Mean....	+ 120.13										
T. B. M. 14	T. B. M. 15.....	951	107.887	Direct	+ 562.0	+ .60	+30.09	−30.09	.40	12.7	13.4770	.....	.....	.....	.....	H.
				Reverse	+ 563.2	− .60									
				Mean....	+ 562.6										
Gauge B. M. W. (Ewens, 1890.)	T. B. M. 14.....	11	107.898	Direct	− 965.5	+ .25	+30.34	−30.34	.17	12.7	12.5118	41.060	.....	.....	.....	W.
				Reverse	− 965.0	− .25									
				Mean	− 965.25										

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals = V.	Σ V. Direct line.	Σ V. Reverse line.	r ±.	R ±.	Elevation above mean Gulf level. 1900.	Elevation above mean Gulf level. 1900.	Elevation above mean Gulf level. Former elevation.	Discrepancy.		Observer.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
Cap of B. M. W	T. B. M. 14	11	107.898	Direct	+ 274.3	0.00	+30.09	−30.09	0.00	12.7	13.7510	45.115				W.
				Reverse	+ 274.3	.00										
				Mean	+ 274.3											
Gauge B. M. D. (Ewens, 1896).	T. B. M. 14	360	108.247	Direct	+1,478.0	− .35	+29.74	−29.74	.23	12.7	14.9647	49.064				W.
				Reverse	+1,477.3	+ .35										
				Mean	+1,477.65											
Gauge B. M. B. (Ewens, 1892).	Gauge B. M. D.	91	108.338	Direct	−1,076.3	+ .25	+29.99	−29.99	.17	12.7	13.8786	45.534				W.
				Reverse	−1,075.8	− .25										
				Mean	−1,076.05											
B. M. 1½⁹	T. B. M. 14	1,349	109.236	Direct	+2,467.8	− .60	+29.49	−29.49	.40	12.7	15.9442	52.311	a 15.7391	+205.1	+0.673	W.
				Reverse	+2,466.6	+ .60										
				Mean	+2,467.2											
T. B. M. 13	B. M. 1½⁹	844	110.080	Direct	−2,574.2	− .15	+29.34	−29.34	.10	12.7	13.3699	43.865				W.
				Reverse	−2,574.5	+ .15										
				Mean	−2,574.35											
T. B. M. 12	T. B. M. 13	631	110.711	Direct	−8,628.1	− .90	+28.44	−28.44	.60	12.7	4.7409					W.
				Reverse	−8,629.9	+ .90										
				Mean	−8,629.0											
T. B. M. 11	T. B. M. 12	842	111.553	Direct	+9,164.8	− .55	+27.89	−27.89	.37	12.7	13.9052					W.
				Reverse	+9,163.7	+ .55										
				Mean	+9,164.25											
P. B. M., Carrs Point.	T. B. M. 11	1,776	113.329	Direct	+2,053.2	.00	+27.89	−27.89	.00	12.7	15.9584	52.357				W.
				Reverse	+2,053.2	.00										
				Mean	+2,053.2											

T. B. M. 10	P. B. M., Carrs Point.	658	118.982	Direct First reverse Second reverse	−2,345.6 −2,341.2	− 2.83 .23	+30.65	−30.65	1.19	13.8	14.0770					H.
				Mean	−2,344.43											
T. B. M. 9	T. B. M. 10	2,134	116.116	Direct Reverse	+ 524.3 + 523.2	− .55 + .55	+30.40	−30.40	.37	12.8	14.1377	46.384				H.
				Mean	+ 523.75											
T. B. M. 8	T. B. M. 9	761	116.877	Direct Reverse	+ 224.2 + 225.3	+ .55 − .55	+30.95	−30.95	.37	12.8	14.3024					H.
				Mean	+ 224.75											
T. B. M. 7	T. B. M. 8	1,014	117.891	Direct Reverse	− 122.5 − 122.5	.00 .00	+30.95	−30.95	.00	12.8	14.2399					H.
				Mean	− 122.5											
T. B. M. 6	T. B. M. 7	1,410	119.301	Direct Reverse	+1,165.0 +1,165.5	+ .25 − .25	+31.20	−31.20	.17	12.8	15.4052	50.542				W.
				Mean	+1,165.25											
P. B. M. L	T. B. M. 6	2,499	121.800	Direct Reverse	+ 805.3 + 801.8	− 1.75 + 1.75	+29.45	−29.45	1.17	12.8	16.2087	53.179	15.9698	+238.9	+ .784	W.
				Mean	+ 803.55											
T. B. M. 5	P. B. M. L	1,427	123.227	Direct Reverse	+ 188.5 + 190.2	+ .85 − .85	+30.30	−30.30	.57	12.8	16.3981	53.800				W.
				Mean	+ 189.35											
P. B. M. LI	T. B. M. 5	565	123.792	Direct Reverse	− 146.3 − 146.6	− .15 + .15	+30.15	−30.15	.10	12.8	16.2516	53.319	16.0105	+241.1	+ .791	H.
				Mean	− 146.45											
T. B. M. 4=H. W. gauge B. M. 49.	P. B. M. LI	713	124.505	Direct Reverse	− 359.3 − 357.3	+ 1.00 − 1.00	+31.15	−31.15	.67	12.9	15.8933	52.144				H.
				Mean	− 358.3											

a Ordinary levels.

TABLE No. 10.—*Tabulation of precise-level results from Baton Rouge, La., to Fort Adams, Miss., 1900*—Continued.

Bench mark.	Determined from.	Length of stretch.	Distance from initial point.	Direction.	Difference of elevation.	Residuals=V.	Σ V. Direct line.	Σ V. Reverse line.	r ±.	R ±.	Elevation above mean Gulf level. 1900.	1900.	Former elevation.	Discrepancy.		Observer.
		Meters.	*Km.*		*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Mm.*	*Meters.*	*Feet.*	*Meters.*	*Mm.*	*Feet.*	
B. M. 1½⁷	T. B. M. 4	710	125.215	First direct	+ 728.5	+ 4.82	+33.78	−33.78	1.14	12.9	16.6266	54.550	a16.3650	+261.6	+0.958	H.
				First reverse	+ 737.2	− 3.88										
				Second direct	+ 736.0	− 2.68										
				Second reverse	+ 734.7	− 1.38										
				Third direct	+ 730.2	+ 3.12										
				Mean	+ 733.32											
P. B. M., Point Breeze; bolt in ⅄ille.	B. M. 1½⁷	83	125.298	Direct	− 1,329.3	− .50	+33.28	−33.28	.33	12.9	15.2968	50.187				H.
				Reverse	− 1,330.3	+ .50										
				Mean	− 1,329.8											
Cap of P. B. M., Point Breeze.	B. M. 1½⁷	83	125.298	Direct	− 118.8	− .35	+33.43	−33.43	.23	12.9	16.5075	54.159				H.
				Reverse	− 119.5	+ .35										
				Mean	− 119.15											
T. B. M. 3	B. M. 1½⁷	210	125.425	Direct	− 2,494.5	− .15	+33.63	−33.63	.10	12.9	14.1320					W.
				Reverse	− 2,494.8	+ .15										
				Mean	− 2,494.65											
T. B. M. 2, river crossing at Fort Adams.	T. B. M. 3	888	126.313	First direct	− 247.3	+ .65	+34.33	−34.33	.04	12.9	13.8853					W. and H.
				First reverse	− 247.7	+ 1.05										
				Second direct	− 246.7	+ .05										
				Second reverse	− 244.9	− 1.75										
				Mean	− 246.65											
P. B. M. XLVIII	T. B. M. 2	413	126.726	Direct	+10,143.7	− .35	+33.98	−33.98	.23	12.9	24.0287	78.835	23.8103	+218.4	+ .717	W.
				Reverse	+10,143.0	+ .35										
				Mean	+10,143.35											
T. B. M. 1	T. B. M. 2	1,289	127.602	Direct	− 170.2	.00	+34.33	−34.33	.00	12.9	13.7151	44.997				W.
				Reverse	− 170.2	.00										
				Mean	− 170.2											

| | | |

TABLE No. 11.

DESCRIPTIONS AND ELEVATIONS OF PRECISE-LEVEL BENCH MARKS, BILOXI, MISS., TO NEW ORLEANS, LA.

[Season, 1900. W. S. Williams and E. L. Harman, levelers.]

Elevations are expressed in both meters and feet above mean Gulf level.

One meter is taken as 3.2808693 feet.

The letters P. B. M. denote a precise-level bench mark which is set with special care so as to be practically permanent. The letters T. B. M. denote a temporary bench mark whose elevation is as well determined as that of a P. B. M.; those described are considered practically permanent for a number of years.

The new precise bench marks established on lines Biloxi, Miss., to New Orleans, La., and Baton Rouge, La., to Fort Adams, Miss., are of the B. M. form as used in 1898 above St. Paul, Minn., for ordinary bench marks, and consist of tile and pipe as follows: A vitrified tile 18 by 18 by 4 inches, in the center of which is set vertically with lead a three-eighths-inch copper bolt, the upper end being a little above the upper surface of the tile. Surrounding the bolt on the surface of the tile is the inscription, "Mississippi River Commission, 1898, U. S. B. M." This tile is buried in the ground about 3 feet beneath the surface. On top the tile is placed a 4-inch wrought-iron gas pipe 4 feet long, concentric with the copper bolt; the lower end of the pipe is split into quarters and spread out to prevent its being pulled up. A cast brass cap fits over the top of the pipe and is riveted thereto. The cap has the following inscription in sunken letters: "Mississippi River Commission, $250 fine for disturbing this mark, 1898, P B. M. U. S., latitude , longitude , elevation above sea ." The P is put on with a prick punch. The elevation of the top of the cap is determined; the structure has thus two bench marks.

P. B. M. E (U. S. C. & G. S.) is near the east end of the Biloxi Bay bridge, and about 68 meters south of the Louisville and Nashville Railroad track, in the yard of and near the northwest corner of the frame house owned and occupied by the Rev. J. B. Walker. The B. M. is the bottom of the square cavity cut in the top of the marble stone marking the point. The stone is 6 by 4 inches on top, and about 2½ feet long, projecting about 4 inches above ground, and has the letters U. S. C. S. cut upon the top. Distance from center of bench to brick pier under northwest corner of house, 0.8 meter.

Elevation, 4.7914 meters, 15.720 feet.

P. B. M. Keenor is tile and pipe, west of summer cottage of Bishop J. C. Keenor, on east side of Biloxi Bay near Ocean Springs, Miss. It is 75 meters north of the Louisville and Nashville Railroad track and about 90 meters east of the east end of the Biloxi Bay Railroad trestle. It is 1 meter west of gallery and 3½ meters north of southwest corner of gallery in front of house.

Elevation bolt in tile, 5.5161 meters, 18.098 feet.

Elevation cap on pipe, 6.7294 meters, 22.078 feet.

Biloxi gauge B. M. B is upper edge of iron plate, at angle in the line of piling near gauge house. Marks are cut thus: ⋀ in the iron, and the letter B is cut in plank near the B. M.

Elevation, 1.6982 meters, 5.572 feet.

Standard staff gauge of Biloxi tidal observations is nailed to piling at northwest end of drawspan, when open, of Louisville and Nashville Railroad bridge over Biloxi Bay. The staff is graduated in feet and tenths from zero to 12 feet, and reads by means of a micrometer attachment to hundredths of a foot. This staff was set in October, 1895. The final value of mean Gulf level reads on this gauge 6.0829 feet.

P. B. M. 19 A is at intersection of X cut on top of stone post on which P. B. M. 19 was originally established. Top has since been broken off. X is on corner of stone nearest the bay. Stone is 225 meters west of the west end of Biloxi Bay bridge. It is 30 meters south of the center of track of the Louisville and Nashville Railroad. Pine trees near by are blazed facing stone.

Elevation, 1.7356 meters, 5.694 feet.

T. B. M. 184 is top of 20-penny wire nail driven vertically into northeast root of leaning sycamore tree standing in northeast corner of yard of the Biloxi, Miss., public school, situated on the south side of the Louisville and Nashville Railroad and on west side of the street which leads south to the city hall. Nail is about one-half inch under the surface of the ground.

Elevation, 5.3620 meters, 17.592 feet.

P. B. M. City Hall, Biloxi, Miss., is top of copper bolt leaded vertically in the top of southeast corner of buttress, standing on the east side of the entrance to the city hall

nd court-house at Biloxi, Miss. Top of buttress is the same height as the water side of building, and is built of brick and covered with cement. Bolt is 0.1 meter om the east and south edges of the buttress, respectively. The city hall is on the rth side of Howard avenue and faces Main street leading south to the beach. Top bolt is nearly flush with surface of buttress.

Elevation, 7.0227 meters, 23.041 feet.

T. B. M. 183 is top of 30-penny wire nail driven vertically into one of the many rtheast roots of the large, lone, double live oak tree standing in open plat of ground longing to the Louisville and Nashville Railroad Company, and which is a pro- ed park. Tree is about 60 meters southwest of the southwest corner of the pas- nger depot at Biloxi, Miss.

Elevation, 7.1855 meters, 23.575 feet.

T. B. M. 186 is top of a 20-penny wire nail driven vertically into south root of 4-foot ve oak tree, standing in northwest portion of same plat of ground as T. B. M. 183. is 13 meters south of warehouse and 115 meters west of the Louisville and Nash- ille Railroad passenger depot at Biloxi, Miss., and 25 meters east of the Hygeia ice lant. Nail is about 3 feet from the body of the tree.

Elevation, 7.2558 meters, 23.805 feet.

P. B. M. Hygeia is tile and pipe in the southeast corner of the yard of the Hygeia e plant, owned by Charles McCormack, at Biloxi, Miss. It is 30 meters south of e ice factory building, 74 meters south of the Louisville and Nashville Railroad, 36 meters west of passenger depot, 118 meters west of P. B. M. Biloxi. Pipe is about 1 meter from south and east fences, respectively, and cap is about 2 feet above ground.

Elevation bolt in tile, 6.5078 meters, 21.351 feet.

Elevation cap on pipe, 7.7212 meters, 25.332 feet.

P. B. M. Biloxi is a brick, concrete, and cement structure, having a M. R. C. B. M. ile with a copper bolt leaded vertically in its center as a subsurface mark, and apped by the same kind of tile. The top tile will eventually have a bronze plate earing a suitable inscription and its elevation marked on it, after the structure has had ample time to settle. A plate will then be published in a subsequent report, howing construction and location of the structure. Said structure is located near ast side of open plat of ground lying southwest of the Louisville and Nashville Rail- oad passenger depot at Biloxi, Miss. The plat of ground belongs to the Louisville and Nashville Railroad Company, and is a proposed park. The P. B. M. is 6 meters west of west line of Fayard street, 52 meters south of passenger depot, 32 meters north of Catholic school yard, 26 meters east of double live oak tree on which is located T. B. M. 183. Top of structure is 2 feet above ground.

P. B. M. 17 is copper bolt leaded in top of marking stone set in ground 11 meters south of center of track of Louisville and Nashville Railroad, 2½ meters west and 1 meter north of southwest corner of the station building at Beauvoir station, Miss. Corners of stone are now chipped off.

Elevation, 7.8647 meters, 25.803 feet.

P. B. M. 16 is center of copper bolt leaded horizontally in center of fifth brick of the fifteenth course above the water table, in the west wall of jail at Mississippi City, Miss. The bricks are counted from northwest corner of building. It is marked U. S. B M.

Elevation, 6.3605 meters, 20.868 feet.

P. M. B. 14 is top of copper bolt leaded in top of marking stone set in ground 8 meters north of center of track of the Louisville and Nashville Railroad, 193 meters east of milepost 62 N. O., and 252 meters east of White Harbor station. Stone marked U. S.

Elevation, 9.4072 meters, 30.864 feet.

P. B. M. 13 is top of copper bolt leaded in top of marking stone marked U. S., set in ground about 9 meters south of center of Louisville and Nashville Railroad track, 5¼ meters south of platform, and 8½ rail lengths east of the east end of the passenger depot at Pass Christian, Miss. Stone projects about 1 inch out of ground and has one corner broken off.

Elevation, 3.3693 meters, 11.054 feet.

P. B. M. 11 is top of copper bolt leaded in top of marking stone, marked U. S., set in ground about ½ meter north of fence along south right of way of Louisville and Nashville Railroad, and about 1 meter west of corner of fence at west side of Front street, in Bay St. Louis, Miss. It is about 12 meters south of center of track and about 30 meters west of west end of railroad trestle over Bay St. Louis. Stone is about 2 inches above ground and has its corners chipped off.

Elevation, 6.5215 meters, 21.396 feet.

P. B. M. 10 is center of copper bolt leaded horizontally in face of southern brick wall of vestibule of Catholic Church at Bay St. Louis, Miss. It is about halfway

between side entrance of vestibule and main front wall and about 1 meter above the ground. Building has been stuccoed over and a hole left in stucco at the bolt.

Elevation, 7.1732 meters, 23.534 feet.

P. B. M. 9 is top of cross in center of marking stone, marked U. S., set in ground 36 meters south of southwest corner of Waveland station, on Louisville and Nashville Railroad, in line with fence on west side of lane along west side of Merwood dairy farm, 12 meters north from corner of fence at end of lane, 12 meters west of shell road leading toward the bay from Waveland station. Stone is 3 inches above ground.

Elevation, 4.7232 meters, 15.496 feet.

P. B. M. 8 is top of cross in center of marking stone, marked U. S., set in ground in northwest portion of yard around the section house at Chinchuba Station, Miss., and about 10 meters south of the center of the Louisville and Nashville Railroad track. Stone is about one-half foot above ground.

Elevation, 2.9598 meters, 9.711 feet.

P. B. M. 7 is center of cross cut in top of marking stone, marked U. S., set in ground just north of north fence of house lot of Pat. Ferril, near Claiborne Station, on Louisville and Nashville Railroad. It is 18 meters south of center of track, 12 meters (measured parallel to railroad track) east of east end of station house.

Elevation, 1.2686 meters, 4.162 feet.

P. B. M. 6 is top of copper bolt leaded into top of marking stone, standing 10 inches above ground, on a high point of ground just east ot East Pearl River, in Mississippi. It is 200 meters east of eastern pier of iron truss bridge, over the East Pearl River, on the Louisville and Nashville Railroad. It is 27.2 meters south of center of track in gravel walk along the front of Baldwin Lodge, and 12 meters west of the house. Property is owned by A. Baldwin, of New Orleans. Stone is marked thus:

1882
U. S.
B. M.

Elevation, 3.1345 meters, 10.284 feet.

P. B. M. 4 is the center of a copper bolt leaded horizontally in wall of Fort Macomb, Chef Menteur, La., on right hand side (as you go in) of entrance. There is a moat around the wall. Bridge over moat has rotted away. Sill to entrance to fort is removed, but wall seems to be in first-class condition. The letters $\frac{\text{U. S.}}{18 \odot 82}$ $\frac{}{\text{P. B. M.}}$ are cut about the bolt.

Elevation, 2.2233 meters, 7.294 feet.

T. B. M. 95 is top of tenpenny wire nail driven vertically in southeast root of 30-inch live-oak tree, the first one north of North Claiborne street, on west side of Elysian Fields street, in New Orleans. It is 14 meters north of gate leading to the residence of Dr. R. Tudury, and stands midway between curb line and granitoid walk.

Elevation, 1.1626 meters.

P. B. M. 41 is top of a vertical copper bolt in brick pier under south post of the electric-light tower at the southwest corner of Anthonia and Claiborne streets, New Orleans. It is 3 inches east of the southeast corner of the iron bedplate, and about 2 feet inside of the curb line on the west side of Anthonia street, and 2.7 meters south of the southwest corner of Anthonia and Claiborne streets. Bolt is about 3 inches under ground.

Elevation, 0.1726 meters, 0.566 feet.

P. B. M. 3, established by the Mississippi River Commission in 1882, is a horizontal mark on end of horizontal copper bolt in the east face of the middle brick gate post of the Gentilly gate, on east side of the fair grounds at New Orleans. The bench mark is in fifth course of bricks above the ground, and is marked thus: U. $\odot$ S.

Elevation, 1.3106 meters, 4.300 feet.

T. B. M. 175 (Paige, 1893) is a + cut on the iron bedplate supporting the southern post of the electric-light tower at the corner of Lapeyrouse street and Gentilly road, New Orleans.

Elevation, 0.6456 meters, 2.118 feet.

P. B. M. 2, established by the Mississippi River Commission in 1882, is the center of end of horizontal copper bolt in the northwest face of the southern wing of the abutment at the northwest end of the drawbridge over Bayou St. John, on the Esplanade road, New Orleans. It is marked thus: $\frac{\text{U. S.}}{\odot}$ $\frac{}{\text{P. B. M.}}$ The brick wing of abutment in which bolt is leaded is very badly cracked (1900) and shows signs of settling.

Elevation, 2.7982 meters, 9.181 feet.

P. B. M. City stone "Halfway House" is a + on top surface of a granite marking stone set in ground, on west side of canal near entrance to Metairie Cemetery, New Orleans. It is in line with the fence along south side of the cemetery, and is 4.7

meters from the southern end of the wall forming the cemetery entrance, and is 41 meters from the western end of the bridge crossing the canal. The top of stone is 120 by 200 millimeters, marked thus: ⊞ and is quite rough, and is lower at the intersection of the + than elsewhere, and the rod was held at this point.

Elevation, 1.6391 meters, 5.378 feet.

TABLE No. 12.

DESCRIPTIONS AND ELEVATIONS OF PRECISE LEVEL BENCH MARKS ESTABLISHED IN 1898 BETWEEN NEW ORLEANS AND THE MOUTH OF SOUTH PASS.

[W. S. Williams and E. J. Thomas, levelers.]

Elevations are expressed in both meters and feet above mean Gulf level.

P. B. M. City stone "XXMR JUNE 1874" is a granite monument 1 foot square in southwest corner of City Park in New Orleans, La., 3 meters from south fence and 3 meters from west fence. The bench mark is the center of upper part of figure 8.

Top of stone marked thus: XXMR JUNE 1874

Elevation, 1.4716 meters, 4.828 feet.

P. B. M. City Park is a cross on highest part of limestone monument, 5 inches square, in City Park in New Orleans, La., 9 meters from west fence and 95 meters from south fence. The cross is about 1 inch south of hole in center of stone.

Elevation, 1.4747 meters, 4.838 feet.

T. B. M. 170 is a point in square cut on the southeast corner of projection of brick post at southeast corner of Calumet National Cemetery, three-fourths of a mile below Jackson Barracks in New Orleans, La., at end of brick wall in front of cemetery, on north side of road, 5 meters from inner base of levee.

Elevation, 2.8518 meters, 9.3564 feet.

P. B. M. 28 is a tile and pipe along line of fence on south side of ditch, near northwest corner of yard in front of main dwelling on Mon Secour plantation, 23 meters back of levee. Has been moved from original position. To northwest corner of main dwelling, 301° 25′, 36 meters. To northeast corner of long building, 351°, 71 meters. To Union sugar house chimney, 187° 22′.

Elevation bolt in tile, 0.3590 meters, 1.177 feet.

P. B. M. 28 A, elevation cap on pipe, 1.5693 meters, 5.149 feet.

T. B. M. 251 is the head of a 4-inch boat spike driven vertically in river side of 24-inch leaning willow, 20 feet directly back of gauge house at Fort Jackson gauge. Tree blazed with a triangle.

Elevation, 1.5718 meters, 5.157 feet.

P. B. M. Jump is a tile and pipe on right bank of Mississippi River, 34 meters below the left bank of The Jump, 51 meters south of south corner of old custom-house and 63 meters south of river bank.

Elevation bolt in tile, 0.5670 meters, 1.860 feet.

Elevation cap of pipe, 1.7796 meters, 5.839 feet.

P. B. M. Southwest Pass No. 1 is a tile and pipe on right bank of Southwest Pass, 2.000 meters below P. B. M. 3, 62 meters back from river bank, 10 meters from edge of swamp, 300 meters below point opposite Head of Passes Light-House. Six-inch willow 1 meter west blazed with a triangle.

Elevation bolt in tile, 0.0663 meters, 0.218 feet.

Elevation cap on pipe, 1.2775 meters, 4.191 feet.

N. B.—The oil house at Head of Passes on which P. B. M. 2 was established has since been moved and the elevation of the P. B. M. consequently destroyed, although the P. B. M. is still there and fills the description.

East Bay gauge is a tide gauge established by C. Donovan, United States assistant engineer, out in the tide water of East Bay about 650 meters southwest of the Port Eads Light. Connection was made with the staff gauge.

Elevation of zero —0.9616 meters, —3.155 feet.

Garden Island Bay gauge is a tide gauge established by C. Donovan, United States assistant engineer, in Garden Island Bay, directly back of the Eads Jetty Company's office at Port Eads, La. It is about 225 meters back from left bank of South Pass. Connection was made with the staff gauge after the clock gauge had been removed.

Elevation of zero —0.9578 meters, —3.142 feet.

NOTE.—For descriptions of all other precise-level bench marks connected with in 1898 in New Orleans and between New Orleans and Head of Passes, see Mississippi River Commission report for 1893. For descriptions of precise level benck marks connected with between Head of Passes and End of Jetties, and stone line bench marks connected with between Donaldsonville and New Orleans, see Mississippi River Commission report for 1894.

TABLE No. 13.

DESCRIPTIONS AND ELEVATIONS OF PRECISE LEVEL BENCH MARKS ESTABLISHED IN 1897–98 BETWEEN NEW ORLEANS AND BATON ROUGE, LA., AND NEW DESCRIPTIONS OF ALL THE COAST SURVEY BENCH MARKS CONNECTED WITH IN 1897–98 BETWEEN NEW ORLEANS AND BATON ROUGE, LA.

[W. S. Williams and E. J. Thomas, levelers.]

Elevations are expressed in both meters and feet above mean Gulf level.

NOTE.—For descriptions of stone line bench marks connected with between New Orleans and Donaldsonville, La., see M. R. C. report, 1894.

City B. M. XX stone is the top of a granite marking stone set in ground in line of trees on west side of electric-car tracks on Carrollton avenue, between Elm and Zimple streets, in Carrollton, La. Top of stone is 1 foot under ground, 44.3 meters from northwest corner of Elm street and Carrollton avenue, 52.9 meters from southwest corner of Zimple street and Carrollton avenue, 14.2 meters from west line of Carrollton avenue, and 2 meters west of west rail of street-car track. Top of stone marked thus: XXMB / June / + / 1874 Rods held on the point indicated on the sketch by a cross; there is no cross on the stone. Bench mark in good condition in 1898.

Elevation, 1.4078 meters, 4.618 feet.

T. B. M. 160 is a nail in west root of 18-inch live-oak tree on east side of Carrollton avenue, first tree north of entrance to school building, McDonough No. 23.

Elevation, 1.9121 meters, 6.273 feet.

P. B. M. "Carrollton" is the center of a small hole in center of copper bolt, leaded horizontally in northeast face of masonry at north corner of school building, McDonough No. 23 (old court-house), on Carrollton avenue, Carrollton, La. The bolt is in the middle of the base of pilaster at corner of building, 0.3 feet below water table of pilaster and about 1.5 feet above ground, marked U. S. ⊙ P. B. M.

Elevation, 2.7338 meters, 8.969 feet.

Gauge B. M. (Carrollton gauge), called "B. M. A (Ewens 1892)," is a stone and pipe located to the left of steps of the entrance to a tin shop, 6 meters back of levee, about 80 meters above end of St. Charles avenue at levee, in flower bed 1 foot from front porch. House belongs to F. Marsel. Cap of pipe marked with the letters U. S. E. B. M.

Elevation bolt in stone, 1.8672 meters, 6.126 feet.

Elevation cap on pipe, 3.1114 meters, 10.208 feet.

P. B. M. V (new position) is a point in square cut on granite sill under the middle of small iron gate to footway on west side of large iron gate at main entrance to yard in front of Judge Rost's house on Destrehan plantation, St. Charles Parish, La., about 12 meters from inner base of levee, marked U. S. ⊡ B. M. This bench mark was moved back about 100 feet in the summer of 1894, when a new levee was built.

Elevation, 4.6195 meters, 15.156 feet.

P. B. M. VI is a point in square cut on top of southwest corner of pedestal under column on the eastern side of steps at front entrance to Edward Sarpy's house on Prospect plantation, St. Charles Parish, La., nearly opposite Hahnville. The pedestal is of brick, covered with hard stucco, 14 meters back from inner base of levee, marked U. S. 18⊡80 B. M. Bench mark in good condition in 1898.

Elevation, 4.1777 meters, 13.706 feet.

P. B. M. VII is the head of an iron bolt in cement post at the foot of a large pecan tree in front of house on estate of Marcellus Roussell, about one-half mile below Gipsy plantation, on Gipsy Point, St. Charles Parish, La. The bench mark is buried beneath

the surface of the ground and covered over with earth. It is 1 foot and 1.5 feet, respectively, from two nails driven in projecting roots of the tree. The tree is blazed with a triangle facing the P. B. M. In good condition in 1898.

Elevation, 4.8204 meters, 15.815 feet.

Chenet is a screw pile 70 meters north of Yazoo and Mississippi Valley Railroad, 25 meters west of east head block of Mount Airy siding, about 50 meters east of a bridge marked L. 36–62, about 1,200 meters below parish line, between St. John Baptist and St. James parishes, and 3 miles below Lutcher, La. The bench mark is a cross on top of cap of pile. Cap is badly broken, but the cross is firm.

Elevation, 3.2396 meters, 10.628 feet.

P. B. M. X is a point surrounded by a groove cut in the upper surface of the granite sill at the foot of iron stairway in front of house of Joseph Lebourgeois, on Mount Airy plantation, St. John Baptist Parish, La., 2½ miles below Lutcher. It is marked with the letters U. S. B. M., 1880. In good condition in 1898.

Elevation, 5.5591 meters, 18.239 feet.

T. B. M. 83 is a nail in root of 12-inch hackberry about 60 meters toward river from Yazoo and Mississippi Valley Railroad track, about 760 meters above depot at Lutcher, La., on edge of N. and S. ditch, and 12 meters west of a 24-inch pecan tree.

Elevation, 4.0283 meters, 13.216 feet.

T. B. M. 71 is a wire nail in north root of 30-inch live-oak tree 20 meters south of Yazoo and Mississippi Valley Railroad track, 12 meters east and 38 meters north of Belmont store, on Belmont plantation.

Elevation, 4.7678 meters, 15.643 feet.

P. B. M. XII is the bottom of a square cavity cut in the cement pedestal of the column at the southwest corner of the mansion house on Belmont plantation, St. James Parish, La., 2½ miles below Jefferson College, at College Point, marked with the letters U. S. B. M. The house on which the bench mark is situated was burned about February, 1894, and the columns only are left standing, about 60 meters outside of new levee, in front of Belmont store, and earth has been borrowed around the ruin for the new levee. The cement is broken off the corner of the pedestal on which the bench mark is situated, leaving only one corner of the square cavity and part of the letters, but the elevation of the bench mark seems to be undisturbed.

Elevation, 5.8488 meters, 19.189 feet.

Homestead is a screw pile on west side of a small ditch, 35 meters south of Yazoo and Mississippi Valley Railroad, 59 meters below milepost 48, 76 meters below large ditch, and 465 meters above quarters on Oneida plantation. The + marking the geodetic point on top of the cap is taken for the bench mark.

Elevation, 4.9294 meters, 16.172 feet.

P. B. M. XIII is a horizontal line cut on two sides of southwest corner of iron post near southeast side of large gateway in front of Jefferson College, at College Point, La. The post stands between the carriage gateway and the footpath gateway, 3.8 feet west of brick buttress and 17.8 feet east of brick buttress, between which lie the gateways. The bench mark is 4.9 feet above brick foundation on which the iron post stands. In good condition in 1898.

Elevation, 7.8723 meters, 25.828 feet.

P. B. M. XIV is the bottom of a square cavity cut in south end of granite doorsill at the most southern entrance on the front or west side of the convent of the Sacred Heart, near Convent post-office, St. James Parish, La. The bench mark is 7 meters north of the southwest corner of the convent and about 4 feet above ground, marked $\frac{U.S.}{B.M.}$ In good condition in 1898.

Elevation, 7.2859 meters, 23.904 feet.

P. B. M. XV is a point in square cut on the northwest corner of stone pedestal of pillar on the south side of entrance to house of George Schepp, St. James Parish, La., formerly owned by Leopold Colomb; house stands about 10 meters back of levee, opposite Colomb station, on Yazoo and Mississippi Valley Railroad, and about 70 meters above Colomb Park store. It is marked $\frac{U.S.B.M.}{X \diamond V}$ In good condition in 1898.

Elevation, 7.1344 meters, 23.407 feet.

P. B. M. XVI is a point in square cut on limestone slab at side of front steps of main residence on Union plantation, 2½ miles below Burnside, La., just back of levee on left bank of river, one-half mile above stone line 190, and 900 meters from Yazoo and Mississippi Valley Railroad. Marked with the letters U. S. B. M. In good condition in 1898.

Elevation, 7.5558 meters, 24.789 feet.

B. M. $\frac{1}{1}$ is a flat stone and iron pipe on Linwood plantation, on north side of road leading back from Linwood Landing, about 600 meters toward river from Yazoo and Mississippi Valley Railroad, 100 meters southwesterly from a large brick house

between road and ditch. Blazed trees: 12-inch magnolia is 5 meters north, 12-inch magnolia 13 meters west. Cap of pipe is gone.

Elevation bolt in stone, 6.1481 meters, 20.171 feet.

Elevation top of pipe, 7.6674 meters, 25.155 feet.

P. B. M. New River is a tile and pipe at New River station, on the Yazoo and Mississippi Valley Railroad, 14½ meters west of track, 83 meters below depot, on west edge of right of way, 18 meters above road crossing, 2 feet from junction of right-of-way fence and fence on north side of road leading to the river.

Elevation bolt in tile, 6.2284 meters, 20.434 feet.

Elevation cap on pipe, 7.4400 meters, 24.410 feet.

P. B. M. XX is a point on the upper surface of the projecting brick foundation running around the house, on Southwood plantation, formerly called Hard Times, at the extreme upper end of Ascension Parish, La. A square opening was cut through the stucco covering, so as to allow the rods to rest upon the brick. The bench mark is marked with the letters U. S. B. M. and the date 1880. In good condition in 1897.

Elevation, 7.1863 meters, 23.577 feet.

P. B. M. St. Gabriel is a tile and pipe near St. Gabriel station, on the Yazoo and Mississippi Valley Railroad, on a small ridge between two small ditches, 1 meter north of fence along south side of road, at east end of lane leading from the river back to railroad station, 31 meters west of southwest corner of depot, 46 meters west of main railroad track, 35 meters from corner of fence on west side of right of way, 10 meters from a 24-inch hackberry tree on which is T. B. M. 25, and 3 meters south of an 18-inch honey-locust tree. Trees blazed with a triangular blaze. Tile is marked with a △ 1895; cap is marked U. S. P. B. M. 1891.

Elevation bolt in tile, 5.4641 meters, 17.927 feet.

Elevation cap on pipe, 6.6723 meters, 21.891 feet.

T. B. M. 22 is the head of a spike driven in west root of a 24-inch pecan tree on east side of road at foot of levee, 6 meters north of gate on crossroad from public road to railroad, 11 meters north of northwest corner of front yard of main house on Willow Glen plantation.

Elevation, 7.7682 meters, 25.486 feet.

P. B. M. XXIV is the bottom of square cavity in top of granite post on left bank of river at Forlorn Hope Landing, 10 meters back of levee, 145 meters in front of Grenada sugar house, 2 meters east of southwest corner of a yard just outside of fence along road, and 65 meters above tramway running from sugar house to the levee. Stone in good condition in 1897.

Elevation, 7.9288 meters, 26.013 feet.

B. M. 17^{2}_{2} is a copper bolt in top of limestone post on left bank at Forlorn Hope Landing, in a back yard, 11 meters north from northeast corner of kitchen, 17½ meters northwest of a 30-inch sycamore tree. Stone in good condition.

Elevation, 7.8333 meters, 25.700 feet.

B. M. 17^{2} is a flat stone and iron pipe on left bank of river opposite Manchac Point, back of Bertville, La., 450 meters east of Yazoo and Mississippi Valley Railroad, about 75 meters south of tramway running back from river to sawmill, and about 50 meters southeast from a house. Stone in good condition, but cap gone from pipe.

Elevation bolt in stone, 5.9378 meters, 19.481 feet.

P. B. M. XXVIII is the bottom of a small square cavity cut in top of marble monument, which is 6 inches square at top, on left bank of Mississippi River, about 4 miles below Baton Rouge, La., on Arlington plantation, about 120 meters west of levee, 40 meters from river bank. Blazed trees: 40-inch live oak 10 meters southeast, 40-inch live oak 20 meters northeast. Monument in good condition in 1897.

Elevation, 9.2901 meters, 30.479 feet.

P. B. M. XXIX is the top of a square cut on top of limestone monument 14 inches square, at south end of Baton Rouge base line; stone is 4 feet under the inner or east slope of levee, 10 feet from inner base of levee, 20 meters below angle in levee, 10 meters down river from plantation line on which stands a 14-inch pecan tree in line of fence along road, 2 meters down river from a point opposite an 18-inch hackberry stump 5 feet high, which stands on opposite side of road 10 meters from P. B. M. and is blazed with a triangle; pecan tree blazed with triangle 14.8 meters from P. B. M. A 4-foot pipe was placed over the copper bolt in center of stone in 1897; its cap is marked U. S. P. B. M. 1891, and it just shows above the slope of the levee.

Elevation top of square on stone, 8.4130 meters, 27.602 feet.

Elevation cap on pipe, 9.6302 meters, 31.595 feet.

NOTE.—P. B. M. XXIX is not of any value as a bench mark on account of the great weight upon it, especially during high water when the levee is thoroughly saturated.

P. B. M. XXX is the top of a copper bolt in top of limestone monument 14 inches square marked with U. S. on north face and 1880 on south face, at the north end of Baton Rouge base line, 700 meters south of city limits of Baton Rouge, La., 80 meters west of Yazoo and Mississippi Valley Railroad, 40 meters east of levee in a truck ditch, 2 meters north of a small ditch, 200 meters below a sugar mill which stands outside of levee. Monument 6 inches above ground and in good condition in 1897.

Elevation, 8.9505 meters, 29.365 feet.

NOTE.—The former elevation of P. B. M. XXX by precise levels is about 1 foot low.

P. B. M. City Limits is the highest point inside the upper part of the figure 8 on top of 6 by 6 inch marble stone marking the southwest corner of the city limits of Baton Rouge, La.; stone is at base of levee 90 meters below south side of South Boulevard. The top of the stone is sloping and is marked CITY LIMITS 1874

Elevation, 9.3145 meters, 30.560 feet.

B. M. 2 U. S. E. is on top of cast-iron coping of brick foundation for iron fence on west side of capitol grounds in Baton Rouge, La., on southwest corner of pedestal under seventh iron post south of northwest corner of capitol grounds, marked $\frac{75}{\text{U S E}}$ Rod held between apex of angle and straight line.

Elevation, 10.4694 meters, 34.348 feet.

T. B. M. 1 is a square cut on north end of lowest granite step of west entrance to State capitol building, Baton Rouge, La.; it is 4 inches from front of step and 4 inches from balustrade.

Elevation, 18.4148 meters, 60.417 feet.

P. B. M. XXXI is a bench mark of the United States Engineers; it is the top edge of the marble foundation stone under center of west side of tower on north side of west entrance to State capitol building at Baton Rouge, La.; it is directly under round window in west face of tower, 27 inches above the ground, 5 inches above the top of granite foundation stone, directly over and 29 millimeters above the horizontal furrow of mark (⊼) cut in the face of the stone. The edge is at the base of the moulding cut in the stone.

Elevation, 18.9504 meters, 62.173 feet.

P. B. M. Barracks is the top of copper bolt leaded vertically into top of southeast corner of pedestal under column at southeast corner of building "B" in university campus (old barracks), in Baton Rouge, La., marked $\frac{\text{P. B. M.}}{\text{U. S.}}$

Elevation, 17.8328 meters, 58.507 feet.

T. B. M. 2 is a 20-penny wire nail in north root of a live-oak tree on south line of small park in center of North Boulevard, Baton Rouge, La., at intersection of North Boulevard and St. Louis street, opposite city hall.

Elevation, 17.1506 meters, 56.269 feet.

P. B. M. Post-office is on Government post-office building at Baton Rouge, La.; it is the top of a copper bolt leaded vertically into corner of water table at the southeast corner of colonnade in front of post-office building, at northwest corner of North Boulevard and Church street, 1,414 millimeters above granitoid pavement and 100 millimeters from southeast corner of water table, marked $\frac{\text{U. S.}}{\text{P. B. M.}}$ Foundation of post-office laid in 1894.

Elevation, 18.0078 meters, 59.081 feet.

P. B. M. North Boulevard is a tile and pipe set on south side of small park in center of North Boulevard, Baton Rouge, La., on line with center of Church street, 36.6 meters from northeast corner of Church street and North Boulevard, 37.6 meters from southeast corner of post-office building, 20 meters east of band stand in park, and 30.7 meters from southwest corner of North Boulevard and St. Ferdinand street, and about 190 meters east of State capitol building. The tile is marked "Mississippi River Commission U. S. P. B. M. 1893," and the cap of iron pipe is marked "Mississippi River Commission U. S. P. B. M. 1897."

Elevation bolt in tile, 15.8652 meters, 52.052 feet.

Elevation cap on pipe, 17.0689 meters, 56.001 feet.

P. B. M. XXXII is the bottom of square cavity in center of granite post buried in flower garden in front of plantation house in West Baton Rouge, La., 90 meters back of levee, 190 meters back from right bank of river, about 200 meters above a point directly opposite State capitol building, and about 400 meters below ferry landing. Stone is 1 foot above ground, in good condition, marked $\frac{\text{U. S.}}{\text{B. M.}}$

Elevation, 8.6247 meters, 28.296 feet.

TABLE No. 14.

DESCRIPTIONS AND ELEVATIONS OF PRECISE LEVEL BENCH MARKS, BATON ROUGE, LA., TO FORT ADAMS, MISS.

[Season 1900. W. S. Williams and E. L. Harman, levelers.]

Elevations are expressed in both meters and feet above mean Gulf level.

T. B. M. 90 is top of a 30-penny wire nail driven vertically in the west root of a 2½-foot live-oak tree standing 1 meter outside of fence back of road and levee; it is the yard fence of J. H. Hill's residence on Homestead plantation. Tree stands in road about half-way between the front gate and the south line of yard.

Elevation, 8.7711 meters, 28.777 feet.

T. B. M. 89 is top of a 30-penny wire nail driven vertically in the east root of a 3-foot pecan tree standing in the road back of levee and 3 meters from the fence, and 1 meter below a large gate. A 5-foot pecan tree stands about 45 meters up the road from B. M. tree. B. M. is 143 meters below the dividing line of Anchorage and Poplar Grove plantations.

Elevation, 9.3888 meters, 30.803 feet.

B. M. $\frac{17}{3}$ is copper bolt in stone post, about 3 inches above ground, on river side of new levee, at its base, and 35 meters below prolongation of fence along south side of yard around the residence of Mr. Auguste Lesseps on the Poplar Grove plantation.

Elevation, 9.9282 meters, 32.573 feet.

T. B. M. 88 is top of a 30-penny wire nail driven vertically in the east root of a 10-inch china berry tree standing in the front yard of Mr. Auguste Lesseps's residence on Poplar Grove plantation, 5 meters from front fence and on lower side of foot-path leading from the road to the house.

Elevation, 9.4405 meters, 30.973 feet.

P. B. M. Poplar Grove is tile and pipe set in ground on the downstream side of front steps to gallery of plantation residence, occupied by Mr. Auguste Lesseps, agent for Mrs. Harris, owner; it is 0.4 meter below downstream outer edge of said steps, and 1.14 meters out from face line of brick pillars under gallery.

Elevation bolt in tile, 8.6012 meters, 28.219 feet.

Elevation cap on pipe, 9.8174 meters, 32.210 feet.

T. B. M. 87 is top of wire nail driven vertically in east root of large live-oak tree standing inside of fence back of road back of levee, 103 meters below the lower edge of residence of Mr. Favrot on the Favrot plantation. The B. M. is on outside of the fence.

Elevation, 9.4881 meters, 31.129 feet.

T. B. M. 85 is top of wire nail driven vertically in root of 8-inch tree standing one-half meter back of fence, back of road, back of levee, back of high water gauge No. 36 on Belair Point.

Elevation, 9.2244 meters, 30.264 feet.

T. B. M. 84 is top of a 30-penny wire nail driven vertically in the south root of a 3-foot live-oak tree standing in the road about 1 meter from inner base of levee. The top of the tree has been cut off. It stands about 2 meters west of the east yard fence and 44 meters east of the entrance to residence on the Viola plantation. It is about 250 meters below Stone Line No. 169.

Elevation, 9.2612 meters, 30.385 feet.

B. M. $\frac{16}{4}$. Flat stone and iron pipe on Viola plantation, 840 meters from levee and on south bank of large ditch; it is 359°, 572 meters from sugar house.

Elevation stone, 7.4710 meters, 24.511 feet.

Elevation cap on pipe, 9.0172 meters, 29.584 feet.

P. B. M. XXXIII is a granite post buried in front of the pillar at the northwest corner of house of Mr. A. Guesnard, Belmont plantation, West Baton Rouge Parish, La.

Elevation, 9.3330 meters, 30.620 feet.

T. B. M. 83 is top of wire nail driven vertically in Osage orange hedge stump standing at side of road at end of hedge, which is the dividing line between Belmont and Lobdell's plantations.

Elevation, 9.6850 meters, 31.775 feet.

T. B. M. 82 is top of 20-penny wire nail driven vertically in bench cut in root, on river side, of Osage orange stump standing one-half meter from fence, 7 meters back of rear corner of G. W. Ory & Co.'s store and Lobdell post-office building, on downstream side of lane leading back from river.

Elevation, 8.9340 meters, 29.311 feet.

T. B. M. 80 is top of 20-penny wire nail driven vertically in bench cut on upstream root of 8-inch china berry tree just inside of fence, back of road, back of levee, and

meters upstream from road crossing levee and leading back to the Allendale sugar mill.

Elevation, 8.3138 meters, 27.293 feet.

P. B. M. Allendale is tile and pipe set in ground in southwest corner of north portion of mule lot, 0.47 meter east of fence, 0.45 meter north of northwest corner of large barn, 9.3 meters west of cistern, 30 meters back of fence back of road back of levee, 64 meters back of center of levee, 48 meters west of road which crosses levee and leads back to the sugar mill on Allendale plantation owned by Mr. Martin Kahoa, and is 14 meters south of east and west fence which runs back of first cabin nearest road.

Elevation bolt in tile, 7.7817 meters, 25.531 feet.

Elevation cap on pipe, 8.9916 meters, 29.500 feet.

P. B. M. XXXIV is a granite post in front of the house of Mr. B. Chamberlain, jr., and is about half a mile above Devall store and post-office at Grassmans Landing, West Baton Rouge Parish, La.

Elevation, 9.5620 meters, 31.372 feet.

T. B. M. 75 is top of a 30-penny wire nail driven vertically in east root of a 2½ foot pecan tree standing in line of fence back of road, back of levee, and on south side of a live-oak grove in front of Mr. A. M. Kean's residence on Batture plantation. Tree is 65 meters northeast of dividing line between Batture and Clarkland plantations.

Elevation, 10.1432 meters, 33.279 feet.

P. B. M. Solitude is tile and pipe, set in ground on Solitude plantation midway between two pecan trees, nearest ones toward levee in a row of three and distant 10 meters from a triangular blaze on each, facing the pipe; blazes are 4 feet above ground. B. M. is on south side of road, 9 meters south of garden fence around house of George Williams, colored, and 50 meters west of levee and 240 meters below square angle in levee (at high-water gauge No. 38), where it leaves river and turns south across point toward Devalls Landing. Cap of pipe is 15 inches above ground.

Elevation bolt in tile, 8.9929 meters, 29.504 feet.

Elevation cap on pipe, 10.1960 meters, 33.452 feet.

T. B. M. 74 is top of a 20-penny wire nail driven vertically in bench cut on south root of 3-foot pecan tree, the easterly one of three in a row on Solitude plantation, and 11 meters east of P. B. M. Solitude.

Elevation, 9.9609 meters, 32.680 feet.

T. B. M. 73 is top of a 20-penny wire nail driven vertically in bench cut on root on river side of sycamore tree standing inside yard fence of James Price (the observer of high-water gauge No. 38), on Solitude plantation. B. M. is 3 inches north of fence, 6 inches north of face of tree, and 15 meters north of northwest corner of house of said Price.

Elevation, 9.8952 meters, 32.465 feet.

T. B. M. 72 is top of a 20-penny wire nail driven vertically in bench cut on root on river side of a large cottonwood tree, with top broken off, standing back of road back of levee 84 meters below corner of fence around field; in said corner stands a large cottonwood tree. B. M. tree is on a small mound of earth, and roots protrude on river side. It is about 1,500 meters above square angle in levee where high-water gauge No. 38 is situated.

Elevation, 9.2866 meters, 30.468 feet.

T. B. M. 70 is top of a 30-penny wire nail driven vertically in the root of a live-oak stump standing in the middle of the road back of levee and nearly opposite the mouth of a lane which has a church on its south side back in field. It is about 375 meters above the residence on Alford's Rosehill plantation.

Elevation, 9.4050 meters, 30.857 feet.

B. M. $\frac{122}{1}$ is a 6 by 6 inch limestone monument on west side of ditch and 4 meters south of intersection of ditches, 252 meters back of new levee, 125 meters in front of new railroad, 150 meters north of an east and west hedge fence, 10 meters north of an 18-inch tree. Stone is leaning toward the ditch, and rod was held on high point inside of lower part of letter S (stone marked U. S. and hole in center). Stone is about west of Highland Landing.

Elevation, 9.2378 meters, 30.308 feet.

P. B. M. XXXV is the bottom of a square cavity in a 6 by 6 inch granite monument projecting 2 inches above ground, standing 1 meter below fence below tramway, running back from river at False River Landing, La., 125 meters below Arbroth store and post-office, 54 meters back from inner base of levee, 14 meters back of small store.

Stone in good condition, marked thus: B. $\frac{\text{U. S.}}{\odot}$ M. 1880.

Elevation, 10.5085 meters, 34.477 feet.

T. B. M. 65 is top of a 20-penny wire nail driven vertically in bench cut in top of large root on back side of large pecan tree on which high-water gauge No. 39 is situated. Tree is the nearest one to the levee, and is near the lower end of a pecan grove, and is 1,000 meters above the present Kelson Landing.

Elevation, 11.0876 meters, 36.377 feet.

B. M. $1\frac{4}{4}$ is stone post standing in fence line back of road back of levee and near middle of front side of pecan grove around the site of the old Robert Clemon residence on Wildwood plantation, the house having been destroyed, but the chimney is still standing.

Elevation, 11.1586 meters, 36.610 feet.

T. B. M. 64 is top of a 30-penny wire nail driven vertically in the north root of a 3-foot gum tree 4 meters inside of fence on south side of road back of levee and about three-fourths of a mile below Hermitage, La., and just above a negro cabin.

Elevation, 10.2947 meters, 33.776 feet.

P. B. M. XXXVI is the bottom of a square cavity in a 6 by 6 inch granite monument flush with ground and marked thus: B. $\underset{1880.}{\overset{U.S.}{\boxdot}}$ M. It is on right bank of river at Hermitage Landing, La., 75 meters below the bank of outlet of False River. A 3-foot live oak, bearing high-water gauge No. 40, stands 10 meters north, and a 2-foot live oak stands 13 meters southwest, both bearing blazed triangles facing stone. The house that originally stood by the P. B. M. is destroyed.

Elevation, 11.5257 meters, 37.814 feet.

T. B. M. 63 is top of a 30-penny wire nail driven vertically in the northwest root of a 2-foot thorn tree. The root is a long one, and the B. M. is about 4 feet from the trunk of the tree. It is 10 meters back of old levee and 149 meters above Grand Bay Landing warehouse.

Elevation, 10.6956 meters, 35.091 feet.

B. M. $1\frac{2}{2}$ is highest point in small square cut on south corner of 6 by 6 inch stone monument projecting 8 inches out of ground, whose top had been broken off, standing 2 meters east of ditch and 17 meters west of west base of old levee and 214 meters below cotton gin at Cooks Landing, La., which is the landing for Anchor post-office.

Elevation, 11.5314 meters, 37.833 feet.

T. B. M. 61 is top of a 10-penny wire nail driven vertically in top of a 4-inch honey-locust stump, which joins a 6-inch honey-locust tree standing at back edge of road back of old levee and 170 meters below cotton gin at Cooks Landing, La.

Elevation, 11.5741 meters, 37.973 feet.

P. B. M. XXXVII is upper edge of a horizontal notch cut in brick on the front face of the building known as the St. Claude Landing warehouse (upper part used as a dwelling), owned by the heirs of Mr. Robin. It is the only brick building in the vicinity. The P. B. M. is nearly on the middle line of the front and 5.4 feet above the ground.

Elevation, 13.7308 meters, 45.049 feet.

T. B. M. 59 is top of a 20-penny wire nail driven vertically in bench cut on root on river side of a 24-inch honey-locust tree standing in square angle of fence on side of road back of levee and about 150 meters below a point in road opposite old sugar mill and three-fourths mile above St. Claude Landing warehouse. Levee B. M. 224 is on same tree.

Elevation, 11.6380 meters, 38.183 feet.

T. B. M. 58 is top of 30-penny wire nail driven vertically in west root of a $2\frac{1}{2}$-foot dead pecan tree standing in middle of road behind levee about 400 meters below high-water gauge No. 41. Levee B. M. 221 is on the same tree on the opposite side.

Elevation, 11.8384 meters, 38.840 feet.

T. B. M. 57 is top of a 20-penny wire nail driven vertically in south root of a 2-foot pecan tree standing in the middle of the road between levee and fence, and is 2,870 meters below P. B. M. XXXVIII.

Elevation, 12.1882 meters, 39.988 feet.

T. B. M. 56 is top of a 20-penny wire nail driven vertically in root of a 2-foot thorn tree standing in center of road behind levee, and is 1,560 meters below P. B. M. XXXVIII.

Elevation, 11.9042 meters, 39.056 feet.

P. B. M. XXXVIII = ◬ S. E. Base is top of copper bolt leaded in top of limestone monument on right bank on Preston plantation 700 meters above division line between Preston and Woodburn plantations. It is about 1 mile below a point opposite Bayou Sara, La. Stone is 14 inches square, projects 6 inches above ground. It is 94 meters back of inner base of levee, 14 meters west of lower end of a deep

e in pasture. Blazed double thorn tree, 2 feet in diameter, stands 75 meters east roadside; blazed dead 2-foot thorn tree north 70°, west 44 meters.

Elevation, 12.0444 meters, 39.516 feet.

T. B. M. 55 is top of a 20-penny wire nail driven vertically in bench cut on root back side of large cottonwood tree on river side of levee, about 80 meters back m river and the same above a clump of timber, and one-half mile below P. B. M. XXXIX.

Elevation, 12.2228 meters, 40.101 feet.

P. B. M. XXXIX = ⓐ N. W. Base is top of copper bolt in limestone monument inches square, standing 2 feet above ground, marked U. S. on west side and 1880 on st side. Concrete bed has dirt partly washed out from beneath it, and it may have n disturbed, as it is at the top edge of the river bank. It is opposite Freehan's rehouse at Bayou Sara, La., and 800 meters below the ferry landing on right nk.

Elevation, 11.9498 meters, 39.206 feet.

B. M. $\frac{1}{2}$ is top of copper bolt in stone post standing in fence line back of road ck of levee 7 meters in front of cotton gin, 30 meters below road crossing levee m ferry landing on right bank opposite Bayou Sara, La. Stone stands 8 inches t of ground; bolt is flush with top of stone.

Elevation, 11.6086 meters, 38.086 feet.

T. B. M. 53 is top of 20-penny wire nail driven vertically in bench cut on root on ver face of 5-pronged cypress tree standing in fence line back of road back of vee and one-half mile below Scott crevasse, about 200 meters below junction of rees and about 500 meters back of right bank of river. Levee B. M. 192 is on ame tree.

Elevation, 9.8085 meters, 32.180 feet.

B. M. $\frac{1}{3}$ is flat stone and iron pipe on right bank in open field on Judge Cooley's plantation on south bank of a ditch, 200 meters from levee, and 655 meters east of Red Store, now Point Coupee post-office. Stone has no bolt in it; rod was held on top of stone at edge of hole where bolt should have been. No cap on pipe.

Elevation top of stone, 9.4598 meters, 31.036 feet.

Elevation top of pipe, 10.9828 meters, 36.033 feet.

P. B. M. XL is the bottom of a square cavity in the top of a granite post 6 by 6 inches standing on the downstream side of steps of residence of Mr. N. Carmanche right bank 67 meters back of new levee, 445 meters below the Union Store, and about 50 meters above the Red Store = Point Coupee post-office.

Elevation, 11.3741 meters, 37.317 feet.

T. B. M. 50 is top of 20-penny wire nail driven vertically in root on river side of a 3-foot live-oak tree standing 1 meter inside of fence back of road back of levee on right bank. Tree is one of three standing in a triangular position. It is 1,010 meters above the Union Store and 350 meters above high-water gauge No. 42.

Elevation, 12.1214 meters, 39.769 feet.

T. B. M. 49 is top of a 20-penny wire nail driven vertically in bench cut on root on river side of 5-foot pecan tree standing in road 2 meters from fence back of levee and 80 meters below P. F. Bourgeois & Son's general store. Levee B. M. 168 is on same tree.

Elevation, 12.3592 meters, 40.549 feet.

P. B. M. XLI is bottom of square cavity in top of 6 by 6 inch marking stone, marked $\frac{\text{U. S.}}{1880.}$, standing at downstream end of steps leading to gallery in front of residence of Mr. Ed. Morrison on right bank immediately back of prominent angle in levee around old crevasse pool.

Elevation, 12.3010 meters, 40.358 feet.

T. B. M. 47 is top of wire nail driven vertically in highest part of large stump standing on south side of road back of levee and 353 meters above P. B. M. XLI.

Elevation, 12.3876 meters, 40.642 feet.

T. B. M. 46 is top of 20-penny wire nail driven vertically in root on north side of a 1½-foot leaning willow tree standing on south side of road back of levee on right bank and 210 meters above angle in levee which is opposite high-water gauge No. 43.

Elevation, 10.6122 meters, 34.817 feet.

B. M. $\frac{1}{2}$ is flat stone and iron pipe in cottonwoods on right bank 500 meters above Morganza crevasse, 80 meters outside of piece of old levee known as Grand Levee, 350 meters outside of outer base of present main levee, 350 meters below prominent angle in same, 1,195 meters below junction of main levee and old Grand Levee, where a watchman's station is located, known by a square enlargement of the levee for a cabin and levee materials. Surrounding trees blazed facing the pipe. Stone has no bolt in it; rod held in center of pipe.

Elevation top of stone, 10.7169 meters, 35.161 feet.

Elevation cap on pipe, 12.2682 meters, 40.250 feet.

T. B. M. 43 is top of period after date 1895 on levee B. M. on levee at watchman's station, known by a square enlargement of the levee for a cabin and levee materials; at junction of old Grand Levee and present main levee, 1 mile above Morganza crevasse, 450 meters below the mouth of lane leading back along lower side of Morganza plantation. (P. B. M. XLII at this junction is either covered up or destroyed.)

Elevation, 16.0294 meters, 52.590 feet.

T. B. M. 40 is highest part of rim around hole of levee B. M., marked U. S. 1895, at top inner edge of levee, at angle, 1,450 meters below lane or State road leading back from New Texas Landing.

Elevation, 15.6430 meters, 51.323 feet.

T. B. M. 39 is top of a 20-penny wire nail driven vertically in the east root of a 2½-foot cottonwood tree, standing in line of fence on south side of State road leading back from levee, at New Texas Landing, La., and on Stone Line 156. Tree is 14 meters back from corner of fence at junction of roads.

Elevation, 10.6089 meters, 34.806 feet.

B. M. $1\frac{8}{8}$ is square marking stone, standing at north side of State road or lane leading back from New Texas Landing, La., 1 meter south of line fence, 279 meters west of corner of fences at mouth of lane, just back of road back of new levee. Edges of stone are chipped off and copper bolt gone. Rod held on highest point of stone.

Elevation, 9.8643 meters, 32.363 feet.

T. B. M. 38 is top of a 30-penny wire nail driven vertically in the northwest root of an 18-inch sycamore tree, standing on north side of road, behind levee, about 375 meters below a Catholic church, and 1,000 meters below Raccourci Landing, La.

Elevation, 11.4851 meters, 37.681 feet.

T. B. M. 37 is top of a 30-penny wire nail driven vertically in the south root of a 2-foot pecan tree standing in the yard of Ed. Lacour's residence, a little above and back of the levee from the store and post-office at Raccourci Landing, La. Tree is 58 meters in front of the house, and is on upper side of walk.

Elevation, 12.0491 meters, 39.532 feet.

P. B. M. XLIII is bottom of square cavity in top of 6 by 6-inch marking stone, set in ground under the front steps to gallery of new house of Edgard Lacour, a little above and back of levee from the store and post-office at Raccourci Landing, La. Stone is under top step, and about 1 foot to left of center; it was in front of the old house.

Elevation, 11.8286 meters, 38.808 feet.

T. B. M. 35 is top of period after date 1895 on levee B. M. at top edge of levee at prominent angle, about 3,000 meters above the residence of Edgard Lacour, near Raccourci Landing, La. Distance taken along the levee.

Elevation, 15.9798 meters, 52.428 feet.

T. B. M. 33 is top of a 30-penny wire nail driven vertically in the north root of a 2-foot china berry tree standing about 15 meters inside of the northwest corner of the yard fence of Mr. V. Lacour's residence, on the Favorite plantation, 4 miles above Raccourci Landing, La., distances along the levee.

Elevation, 14.3252 meters, 46.999 feet.

P. B. M. XLIV is bottom of square cavity in top of 6 by 6 inch marking stone, nearly flush with ground, standing at lower side of steps, in angle where they join the gallery on front of house of Dr. A. A. Batchelor, 220 meters back of fence, back of road, back of levee, back of Old River. It is 1¾ miles above the Ennis Oil Mill and 2½ miles below the town of Williamsport, on Old River.

Elevation, 13.7286 meters, 45.042 feet.

T. B. M. 22 is top of a 30-penny wire nail driven vertically in the south root of a 4-foot cottonwood tree on west side of road, back of levee. Tree is 30 meters south of blacksmith shop at the lower end of the town of Williamsport, La., on Old River.

Elevation, 14.8995 meters, 48.883 feet.

T. B. M. 20 is top of a 30-penny wire nail driven vertically in the east root of a 2½-foot pecan tree standing 3 feet west of north and south hedge fence on west side of road behind levee. Tree stands near where B. M. $1\frac{9}{9}$ should be. B. M. pipe was pulled up and found lying by the side of the road. Tree is about 400 meters below house occupied by Mr. A. J. Noland.

Elevation, 15.1219 meters, 49.613 feet.

P. B. M. Smithland is tile and pipe set in ground on northeast corner of yard of plantation residence owned by Mr. Archie D. Smith and occupied by Mr. A. J. Noland. Pipe is 1 meter from each fence in said corner, and is back of road back of levee, 780 meters below Smithland Landing and post-office, Louisiana, and 300 meters below where road crosses levee leading south from the landing. There is a row of 6 large live-oak trees in the front yard. The P. B. M. is 30 meters north of the end and 4 meters east of the prolongation northward of this row.

Elevation copper bolt in tile, 13.4451 meters, 44.112 feet.
Elevation cap on pipe, 14.6584 meters, 48.092 feet.
P. B. M. XLV is bottom of square cavity in top of 6 by 6 inch granite marking site, marked thus: B ⊙ M. (U. S. 1890) flush with ground, standing 22 meters back of right bank of river, in lot 3 meters north and west, respectively, of two fences. It is northeast of warehouse, in rear of which is Smithland post-office, at Smithland Landing, La.
Elevation, 14.8234 meters, 48.634 feet.
T. B. M. 17 is top of wire nail driven vertically in bench cut on river face of 5-inch elm tree standing on edge of barrow pit at back edge of road back of levee, opposite prominent angle in same at junction of old levee leading southeast toward river, and about 1,300 meters above Smithland Landing, La.
Elevation, 14.3957 meters, 47.230 feet.
B. M. W. (Ewens, 1890), Red River Landing, La., gauge B. M., is copper bolt in stone slab, under ground, with iron pipe on top. It is in the front yard, just to the left of gate as you enter, of Mr. Rodech's residence, back of levee at Red River Landing, La.
Elevation bolt in stone, 12.5118 meters, 41.050 feet.
Elevation cap on pipe, 13.7510 meters, 45.115 feet.
B. M. B. (Ewens, 1892), Red River Landing, La., gauge B. M., is top of large nail driven vertically into bench cut on river face of large cypress nearly in front (a little below) of Mr. G. W. Reagan's store.
Elevation, 13.8786 meters, 45.534 feet.
B. M. D. (Ewens, 1896), Red River Landing, La., gauge B. M., is top of nail, driven vertically into a bench cut on large sycamore tree standing on little knoll directly back of Mr. G. W. Reagan's residence.
Elevation, 14.9547 meters, 49.064 feet.
B. M. 1½² is a 6 by 6 inch limestone monument on right bank, standing on inner slope of levee, 5 feet above the base, in line with center of lane running back from river, and just above wagon road crossing levee. It is 154 meters (along levee) below Catholic church, and about 1 mile above Red River Landing, La. Rod was held on highest part of the letter S, which is inside lower half.
Elevation, 15.9442 meters, 52.311 feet.
T. B. M. 13 is top of 30-penny wire nail driven vertically in the east root of a 4-foot willow tree, on right bank, 840 meters above B. M. 1½², 600 meters above the mouth of Old River (or Red River), and 35 meters back from right bank of Old River.
Elevation, 13.3699 meters, 43.865 feet.
P. B. M. Carrs Point is top of copper bolt cemented in top of 6 by 6 inch marble monument projecting 10 inches out of ground, standing in line of fence running east and west on south side of road running in front of cabins on Carrs Point plantation, owned by Lewis Trager. It is 257 meters back from right bank and 9½ meters south of south line of cabins; 74 meters east of cabin, and 112 meters west of third cabin from river. It is 1 mile above the mouth of Old River (or Red River). Monument marked thus: ⊙ (U. S. N. O.)
Elevation, 15.9584 meters, 52.357 feet.
T. B. M. 9 is top of 20-penny wire nail driven vertically into bench cut on base of 36-inch sycamore tree, on river face, standing 10 meters back of main right bank, and 2 meters back of road. It is about 230 meters below a small levee standing square with the river bank, and 1½ miles above Carrs Point Landing, La.
Elevation, 14.1377 meters, 46.384 feet.
T. B. M. 6 is top of 20-penny wire nail driven vertically into root (facing river) of a 2½-foot locust tree, 5 meters from top of right bank, and about 200 meters above fence at lower end of field. It is 2,500 meters below P. B. M. L., and is opposite Tarbert Landing, Miss.
Elevation, 15.4052 meters, 50.542 feet.
P. B. M. L=◬ S. W. Base, is top of copper bolt in top of stone monument, 14 inches square on top, set flush with ground, on land of B. M. Lemley, of Vicksburg, Miss. It is 60 meters above and 76 meters back of a 1½-story house on road, top of right bank. It is 21 meters above lane running back from river and 7 meters back of turn row or headland in cotton field, and 18 meters toward river from corner of garden.
Elevation, 16.2087 meters, 53.179 feet.
T. B. M. 5 is top of a 20-penny wire nail driven vertically into west root of a 3-foot sycamore stump on east side of north and south road, along east side of cotton field. There is timber east of road. It is 565 meters below P. B. M. LI=◬ N. E. Base.
Elevation, 16.3981 meters, 53.800 feet.
P. B. M. LI=◬ N. E. Base, is top of copper bolt in top of stone monument, 14 inches

square on top, standing nearly flush with ground in cotton row, 7 meters south of southwest corner of garden fence back of negro cabin owned by Eli Lennox, and 23 meters southwest of said cabin, on land of G. W. Reagan, 80 meters above line fence between Reagan and Lemley, and about 45 meters back of road along top of main right bank. It is 1 mile below the upper end of Point Breeze.

Elevation, 16.2516 meters, 53.319 feet.

T. B. M. 4=high-water gauge B. M. 49, is top of 40-penny wire nail driven horizontally into inner face of 6-inch thorn tree, one of three standing together on slope of main right bank, back of willow and cottonwood timber. It is a little above and in front of large cabin occupied by Rev. Rickson Jones (colored), the observer of the gauge. It is 710 meters above ◬ N. E. Base and 900 meters below the upper end of Point Breeze. The gauge is nailed to the outer one of the three thorn trees mentioned.

Elevation, 15.8933 meters, 52.144 feet.

P. B. M. Point Breeze is tile and pipe planted in ground, 3 meters outside of road and 8 meters back from top of main right bank, on Point Breeze, 66 meters below B. M. $1\frac{1}{2}$, and about 335 meters below the upper end of Point Breeze, measured along the high bank. Cap on pipe is about 9 inches above ground.

Elevation bolt in tile, 15.2968 meters, 50.187 feet.

Elevation cap on pipe, 16.5075 meters, 54.159 feet.

B. M. $1\frac{1}{2}$ is top of small square cut on top of 6 by 6 inch marking stone, projecting 6 inches out of ground, standing in south end of lane on top of main right bank, on Point Breeze, about 270 meters below the upper end of the point. It is immediately east of the second cabin below the upper end of the point, cabin occupied by Uriah Pollock.

Elevation, 16.6266 meters, 54.550 feet.

P. B. M. XLVIII is bottom of square cavity in top of 6 by 6 inch marking stone standing on small flat on side of bluff, about 400 meters below the present landing for Fort Adams, Miss., about 30 meters above a ravine. It is between and a little back of two small cabins on the flat and 50 meters back of a large house standing at the foot of the slope. The store that originally was near stone is gone. The bluff above and below stone has been sliding into river, but seems stable around stone. Stone in good condition.

Elevation, 24.0287 meters, 78.835 feet.

T. B. M. 1 is top of a 20-penny wire nail driven vertically into east root of a 2-foot willow tree standing in road at foot of bluff, about 600 meters below the lower end of the village of Fort Adams, Miss., 635 meters below P. B. M. Fort Adams, and 1,300 meters above the present landing on the river for Fort Adams.

Elevation, 13.7151 meters, 44.997 feet.

P. B. M. Fort Adams is tile and pipe planted in ground in the front yard of Mr. H. L. Stutzmans, on the east side of Main street and north side of street running east to foot of bluffs, in the lower end of the village of Fort Adams, Miss. It is $3\frac{1}{2}$ meters east of the northeast corner of the street intersection, 3 meters south of the southwest corner of the house, 69 meters below the south end of bridge over ravine. P. B. M. is 455 meters below P. B. M. XLIX.

Elevation bolt in tile, 15.7623 meters, 51.714 feet.

Elevation cap on pipe, 16.9712 meters, 55.680 feet.

P. B. M. XLIX is bottom of square cavity in top of 6 by 6 inch marking stone standing at southwest corner of the house of Mr. Baker, just above the corners at the upper end of the village of Fort Adams, Wilkinson County, Miss. Stone in good condition.

Elevation, 20.8994 meters, 68.568 feet.

APPENDIX 2 F.

REPORT OF MR. KIVAS TULLY, ASSISTANT ENGINEER, ON WORK PERTAINING TO GAUGES, REDUCTION OF PHYSICAL DATA, OFFICE RECORDS AND PUBLICATIONS.

ST. LOUIS, MO., *May 31, 1900.*

CAPTAIN: I have the honor to submit the following report of the work pertaining to gauges, reduction of physical data, office records and publications since May 31, 1899:

PERMANENT GAUGES.

The permanent or regular gauges of the Commission comprise 14 on the Mississippi River, between St. Louis, Mo., and the Head of the Passes, La.; 1 on the St. Francis River at the St. Louis, Iron Mountain and Southern Railroad Bridge; 1 on the White

River at Clarendon, Ark., and 1 at Barbre Landing, at the head of the Atchafalaya River. The self-registering tide gauge has also been maintained near Biloxi, Miss.

All the Commission gauges, except those on the White and St. Francis rivers, have been inspected during the year; those on the main river were inspected at about the lowest stage of the season. The results of the inspections are given in detail below. The errors found in the gauges generally did not exceed 0.2 foot, except at Bayou Sara and Barbre Landing, where large errors were found. Sketch maps of the immediate vicinity and site of each of the Commission gauges will be found in the Report of the Chief of Engineers for 1893, following page 3660. Any changes in location made since are noted below.

Cape Girardeau, Mo.—This gauge was inspected December 15, 1899, at a stage of 6.7 feet; this was 2.7 feet above the lowest of the season. The section in use was leaning, and at upper end was 0.06 foot too low. High-water sections were practically correct.

Belmont, Mo.—This gauge was inspected October 4, 1899, at a stage of 4.42 feet, which was 1.45 feet above the lowest of the year. The gauge was found practically correct.

New Madrid, Mo.—This gauge was inspected on October 6, at a stage of 3.68 feet, which was 1.08 feet above the lowest of the year. The gauge was practically correct, the largest error being 0.04 foot. A new section was put in, reading from zero to 10 feet. The bulletin was repainted.

Cottonwood Point, Mo.—This gauge was inspected October 9, at a stage of 0.94 foot, which was 1.14 feet above the lowest of the year. The error in the section in use was 0.09 foot. The inclined section from 13 to 36, and sections 35.5 to 43 feet were practically correct. The gauge was rebuilt from -1.0 to $+9$ feet. The bulletin was repainted. The present site of this gauge is about one-half mile upstream from the site of 1893.

Fulton, Tenn.—This gauge was inspected on October 11, at a stage of 3.39 feet, which was 0.76 foot above the lowest of the year. The section in use was correct. Errors of 0.02 to 0.07 foot were found in the upper sections; the section from 18 to 22 feet had been destroyed. The gauge was rebuilt from zero to 22 feet; the bulletin was left in good condition.

Mhoon Landing, Miss.—This gauge was inspected on October 16, at a stage of -4.44 feet, which was 0.36 foot above the lowest of the year. An error of 0.18 foot was found in a low-water section said to have been in use, but the reading reported by the gauge keeper for that time agreed with the elevation found by leveling. The section 24 to 30 feet was 0.08 foot too low; other sections were correct. The gauge was rebuilt from -5 to 24 feet in 4 sections, placed about 400 meters downstream from the high-water sections, and 650 meters below the present Mhoon Landing, on a sloping bank. The present site is about a mile above the site of 1892, and about one-half mile below the original site of this gauge. The bulletin was repainted.

Sunflower Landing, Miss.—This gauge was inspected on October 20 at a stage of 3.12 feet, which was 0.36 foot above the lowest of the year. The section of gauge in use was 0.06 foot to high. The high-water section was practically correct; errors of less than 0.06 foot were found in other sections. The various sections were firmly set and were not rebuilt. The bulletin was repainted.

Arkansas City, Ark.—This gauge was inspected on October 24 at a stage of 1.33 feet; this was 0.33 foot above the lowest stage of the year. The section in use was 0.2 foot too high. The sections from 24 to 50.5 feet were 0.04 foot too high. The sections from 8 to 24 feet were from 0.06 to 0.08 foot too high. Section 50 to 54 was 0.08 foot too high. Other sections were practically correct. The gauge was rebuilt from 0 to 16 and from 32 to 41 feet. The bulletin was repainted.

Greenville, Miss.—This gauge was inspected on October 25 at a stage of 1.59 feet; this stage was 0.39 foot above the lowest of the year. The low-water section, from 0 to 11.4 feet, was 0.11 foot too high by comparison with water surface as determined by leveling. The section was not leveled to directly. The high-water section, 43 to 50 feet, was correct. The inclined section, 11.4 to 43.5 feet, which had been built on the inclined railway of the Vicksburg and Greenville Packet Company for use during bank-protection work at the old site, was slightly in error, the error varying from 0.01 to 0.06 foot. This section was extended down to 6.3 feet. A new low-water section reading from -3 to $+7$ feet was nailed to the dump piling about 300 meters above the inclined gauge.

St. Joseph, La.—This gauge was inspected on November 3 at a stage of -5.03 feet. This stage was 0.17 foot above the lowest of the year. All the sections of this gauge below 33 feet had been destroyed by caving bank; the temporary section in use, -2 to -5.2 feet, was 0.05 foot too high. The high-water section, 39 to 51 feet, was practically correct. The gauge was rebuilt from -6 to 33 feet on an apparently stable

bank between the warehouse and the river. The high-water section is a short distance above the warehouse. The bulletin was repainted.

Bayou Sara, La.—On September 22, 1899, the observer leveled from a permanent section by means of a straightedge and carpenter's level, and found the section in use that day to be 1.9 feet too low. Readings were continued on this section until the inspection party arrived on November 13, when the section was found to be 2.2 feet too low. The error was evidently caused by settlement of the bank, the office hydrograph indicating that it began early in August. The records have been corrected on the assumption that the errors gradually accumulated from August 7, 1899. Section 12 to 15 feet was 0.01 foot too low; section 15 to 19 feet was 0.12 foot too low; section 19 to 24 feet was 0.02 foot too low. The gauge was rebuilt from —3 to 12 feet and from 15 to 19, and 24 to 44 feet. The gauge was inspected at a stage of —1.06 feet, which was 0.34 foot above the lowest of the year. The bulletin was repainted.

Plaquemine, La.—This gauge was inspected on November 16, 1899, at a stage of 0.77 foot; this was 0.73 foot above the lowest of the year. The section in use, —2 to 4 feet, was found to be 0.14 foot too high. The inclined gauge, 14.2 to 24 feet, was slightly in error, the error ranging from 0.04 to 0.09 foot at different parts. It was not reset. The section 28 to 40 feet was 0.15 foot too low. The gauge was rebuilt from about —2 to 10 feet, 24 to 28 feet, and from 28 to 40 feet. The bulletin was repainted.

College Point, La.—This gauge was inspected on November 17 at a stage of 0.41 foot; this was 0.8 foot above the lowest of the season. The section in use, 0 to 2 feet, was found to be 0.04 foot too low. The inclined section, 11.1 to 22.2 feet, set in January, 1899, had been partly pulled up during high water, and was reset by the district surveyors. At the inspection this section was correct at the upper end and 0.06 foot too low at the lower end; it was not reset. The gauge was rebuilt from 6 to 12 feet. The bulletin was repainted.

Fort Jackson, La.—This gauge was inspected on November 22, 1899. It was found to be 0.02 foot too low at the 7-foot mark. The figures were somewhat indistinct and the gauge was rebuilt from 0 to 10 feet. The gauge was inspected at a stage 1.22 feet above the lowest of the season.

Barbre Landing, La.—This gauge, in Old River near the head of the Atchafalaya, was inspected on November 11. The low-water sections were found in very bad condition, all below 12 feet having been disturbed by sliding banks and other causes. The gauge was inspected at a stage of 0.64 foot, which was about 1.94 feet above the lowest of the season. The section in use from —2 to +5 feet was 2.35 feet too low. The back records were corrected on the assumption that this error had accumulated since the water passed below the 12-foot stage, in August, 1899. The high-water section, 39 to 51 feet, was 0.03 foot too low; other sections were in error 0.02 to 0.05 foot. The gauge was rebuilt from —2 to 28 feet.

A hydrograph showing the daily readings of gauges on the Mississippi River, Cairo to Fort Jackson, from June 1, 1899, to May 31, 1900, is given on plate 3.

The highest and lowest readings of gauges on the Mississippi River and its principal tributaries, comprising 58 stations, for the year 1899, are given in Table No. 15. The elevations of gauges and distances from Cairo are also given in this table.

The comprehensive hydrograph of the main river and tributaries, from 1871 to 1899, inclusive, has been completed, and is given on plate 4.

HIGH-WATER GAUGES.

These gauges were visited by the gauge-inspection party during October, November, and December, 1899. The gauges were leveled to and left in good order. Arrangements were made with persons residing near the gauges for recording the high water should the river reach such a stage this season.

LOW-WATER SLOPE.

The elevation of water surface at or near the sites of the high-water gauges on the Mississippi River below Cairo was determined during October and November, 1899. These determinations were made at nearly the lowest stages of the season, under unusually favorable conditions. These elevations have been corrected to agree with the lowest stages at the nearest permanent gauges. The lowest water reading occurred at the permanent gauges very regularly at about the usual rate of progress down the river as far as Natchez. The time interval between Cairo and Natchez was eleven days. The slope between the successive gauges has been computed from these corrected elevations as far down as the mouth of Red River. Below that point the tidal

feet is so marked at low water as to prevent the precise determination of river slope. A profile of the river below Cairo showing the low-water slope is given on plate 2. The tabulated results of the slope observations will be found in Table No. 16.

BILOXI TIDE GAUGE.

The results of observations to March, 1899, and a description of this gauge and its bench marks will be found in the Report of the Chief of Engineers for 1899, pages 3470 and 3476. The mean reading on this gauge, 6.083 feet, given in that report, was adopted on June 21, 1899, by the Mississippi River Commission as the final value of mean Gulf level and as the reference plane for elevations of all bench marks hereafter. The record for the balance of the year 1899 has been reduced, the mean reading for the year being 6.0809 feet. This gauge was inspected by the precise-level party in March, 1900, and from connection with the permanent bench marks on shore the staff had apparently settled 0.015 foot since the previous inspection of April, 1898. Assuming that this error accumulated gradually, and applying the correction of −0.009 foot, we have for the mean reading of 1899, 6.072 feet.

In June, 1899, some changes were made in the swing or drawspan of the bridge and it was found that a projecting rail of the new span, when open, knocked against the tide gauge house. In February, 1900, the house was moved sufficiently to avoid this. In August, 1899, the metal float band broke, having become badly corroded, and on August 30 a new band and counterweight were put on to replace the old ones. The record has been fairly good and practically continuous during the year. B. M. A and B. M. C were destroyed by the changes in the drawspan.

The question of subsidence of the delta of the Mississippi has been discussed at length in the Appendixes to reports of the commission for 1894 and 1896. See Reports of Chief of Engineers for those years, pages 2794 and 3478, respectively. The investigation has been continued since then, and it is believed that now sufficient data have been collected to show conclusively that the lower delta of the Mississippi River is subsiding, the amount of subsidence from 1882 to 1896 being approximately shown by the Port Eads gauge, and from 1895 to 1900 shown very accurately by the East Bay gauge.

In the following tables the readings for Biloxi were obtained from the tide rolls in this office. The readings for Port Eads and East Bay were obtained through the courtesy of Maj. H. M. Adams, Corps of Engineers, U. S. A.

As shown by the gauge curves on plate 10, Report of Chief of Engineers for 1899, page 3502, the Port Eads records are materially affected by the river stages, while those for East Bay are very slightly affected, and then only at very high stages. For these reasons the East Bay gauge is entitled to greater weight in any comparisons with Biloxi, and may safely be taken as representing the true Gulf level at the delta. The East Bay gauge was established in 1895, while the records of Port Eads gauge extend back to 1876. For comparison with Biloxi in 1882–1884 the Port Eads are the only records available and they have therefore been used. The resulting differences, however, must be regarded as only approximately representing the subsidence of the delta.

The level connections between the gauges and their local bench marks show no progressive change in their relations with the exception of the change at Biloxi in 1899 already referred to.

The changes in the relations of the gauges at Biloxi and East Bay must therefore be caused by a general raising of the strata at Biloxi or a lowering of the strata at East Bay, or partly by both. But if Biloxi has risen New Orleans must also have risen, as the precise levels recently run between these places indicate that New Orleans is, if anything, relatively slightly higher than in 1882. It is likely, however, that the slight change found was due to errors in leveling. That New Orleans has not risen is indicated by the precise level connection completed in February, 1900, which shows New Orleans relatively lower than in 1880. Therefore the conclusion seems inevitable that the lower delta of the Mississippi has subsided.

By comparisons between Biloxi and Port Eads from 1882 to 1896 (see Table No. 17) the subsidence amounts to 0.696 foot; from 1896 to 1899 by the same gauges it amounts to 0.31 foot; a total subsidence from 1882 to 1899 of 1.006 feet, which gives an average rate of 0.056 foot per year.

By comparisons between Biloxi and East Bay from 1896 to 1899 the subsidence is 0.316 foot, or an average rate of 0.079 foot. The rate of subsidence from 1896 to 1899 is not uniform, as will be seen in the table, and therefore can not safely be used in deducing a rate prior to 1896.

The following gives the differences in readings of Port Eads and East Bay during the period 1896–1899, which may be taken as indicating river effect at the former station:

Year.	Port Eads.		East Bay.		Differences.		
	High.	Low.	High.	Low.	High.	Low.	Mean.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1896	3.974	2.684	3.595	2.146	0.379	0.537	0.458
1897	4.111	2.870	3.709	2.310	.402	.560	.481
1898	4.279	3.042	3.829	2.439	.450	.603	.526
1899	4.231	3.063	3.824	2.466	.389	.597	.493

The means of the high and low tides for each lunation have not previously been published for Biloxi and are therefore given in this table, as well as the mean tide. The high and low tides for Port Eads and East Bay are published in Report of Chief of Engineers for 1899, page 1830. Only the means are given here for comparison. The mean annual range of tide at these stations for the last four years are as follows:

Year.	Biloxi.	East Bay.	Port Eads.
	Feet.	*Feet.*	*Feet.*
1896	1.815	1.449	1.290
1897	1.756	1.399	1.241
1898	1.776	1.390	1.237
1899	1.666	1.376	1.171
Grand means	1.753	1.404	1.235

In the above period the highest tide at Biloxi occurred September 21, 1898, and read 9.38 feet on the gauge; the lowest occurred February 13, 1899, and read 2.84 feet on the same gauge. The tide having maximum range in 1897 was January 31, 9.35 p. m., to February 1, 1.15 p. m., reading, respectively, 9.17 feet and 4.20 feet; range, 4.97 feet. The same for 1898 was from January 19, 6.45 p. m., to January 20, 9.30 a. m., reading, respectively, 8.97 feet and 4.17 feet; range, 4.80 feet. The tidal oscillations are no doubt affected by the atmospheric pressure and winds. No barometer records have been made and only approximate notes on the wind have been recorded at this station. The tabulated readings all refer to the present gauge at each place. Corrections have been applied for any changes known to have been made in the gauges.

DISCHARGE OBSERVATIONS.

Low water, 1899.—The low-water discharge of the Mississippi River was measured six times during October and December, 1899, at New Madrid, Mo., by the survey party in charge of Mr. Charles H. Miller. The results of the final reduction in this office are given in Table No. 18.

The experiment was tried this year of using two meters simultaneously for measuring the velocities. The Haskell meter with wheel No. 6 was used with the Price meters, using alternately Price meters No. 29 and No. 34. The former is of the propeller type of wheel and the latter two are of the anemometer type. The velocities obtained by each meter are given in Table No. 19. The results of these agree very closely. The discharges measured by the Price and Haskell meters simultaneously and by rod floats on the same day are as follows:

Date.	Method.	Discharge per second.	Discrepancy (per cent).
1899.		*Cubic feet.*	
December 8, a. m.	Rod floats	129,929	Two-tenths of 1 per cent greater (compared with mean of meter results).
December 8, p. m. (simultaneously).	Price meter, No. 34	131,227	2.4 per cent greater (compared with Haskell meter).
	Haskell meter, wheel No. 6.	128,129	

This date was selected for comparison, as on it rod-float measurement was also made.

The discharge section was established between ranges 8 and 9 of the scour and fill survey, as shown on Plate 1. Soundings were taken across the discharge section or range from a skiff, the recorder in the skiff signaling with a flag at each sounding to a transit station on shore above the discharge range. A ¼-inch cotton line was used with a 9-pound lead. Soundings were mainly about 30 to 40 feet apart. The soundings were corrected for any errors found in the lead line.

Fourteen velocity stations were laid out on the discharge section; these were located from a series of fixed signals on shore. The distance between the velocity stations was 150 feet; the end stations were about 80 and 90 feet from shore. The meter observations were taken from a skiff, which was successively anchored at each velocity station, where the meter was run for 200 seconds at six-tenths the total depth. Two meters were used simultaneously, one on either side of the skiff, about 8 feet apart.

The reduction of the observations has been made in the usual manner. The cross section was divided into partial areas corresponding to the velocity stations, the partial areas extending on either side of the velocity station half way to the adjacent station. These partial areas were multiplied by the velocity of the corresponding station; this gives a series of partial discharges, the sum of which is the total discharge of the river. The mean velocity is obtained by dividing the total discharge by the total area of the cross section.

One discharge, on December 8, 1899, was measured with rod floats immersed to nine-tenths of the total depth. Fifteen floats were run; it was designed to have them come as near as possible to the regular velocity stations. The float ranges were laid off 100 feet above and 100 feet below the discharge range, the point of crossing the discharge section being taken for the float-velocity station in computing partial areas. The vertical component of the float path was used in deducing the velocity. The rod-float velocities thus obtained were reduced by Francis' formula, which gives for this immersion a coefficient 0.975 by which to multiply the observed velocity.

The float paths showed a maximum deflection from a normal to the discharge range of about 8°; the mean of all was about 5°. This would give a correction to the meter discharges measured on the same day of less than one-half of 1 per cent, the observed discharges being that much too great; this correction was applied, but only to the discharges of December 8.

Series of rating observations were made with all the meters both before and after the period of discharge measurements. Owing to uncertainty in time record of the first series the results are doubtful and have not been used in the final computation except for computing velocities of Price meter No. 34 of October 18, as evidently some change had occurred in this meter between that date and October 30.

The second series of rating observations made in March, 1900, is very satisfactory both as regards number and distribution of velocities, and the residuals shown by the graphical reduction are quite small. Two ratings were made for each meter in this series, and both being equally good, the arithmetical mean of the two values of each constant was taken for deducing velocities. The meter ratings have all been reduced by the method of least squares; the results are given in Table No. 19.

St. Francis River discharge, 1898.—The results of some discharge measurements made on the St. Francis River by the party on the steamer *Patrol* during the low-water inspection trip of 1898 have been deduced and are given in Table No. 18. The stage at which these observations were made was considerably above low water.

Flood discharges of the Mississippi River, 1851 to 1898.—The accompanying plate (5), which has been prepared under your direction, is designed to present in a limited space the results of all measurements of flood discharges of the Mississippi River below Cairo. These results have been collected from various official publications, mainly those of the Mississippi River Commission, and all gauge readings have been referred to the present gauge at each station. The gauge curves and discharges are all referred to the same origin for each station; a comparison of discharge and corresponding gauge heights can therefore readily be made.

The different methods of measuring discharges are distinguished by their respective symbols; the generally close agreement between the results of very dissimilar methods seems to sustain the reliability of discharge measurements. For the purpose of showing the relative magnitudes of the high and low water discharges on this scale the extremes measured at Columbus, Ky., are also shown.

All of the discharges on the main river below Cairo since 1879 have been made by the Mississippi River Commission, and the final computations of nearly all of them have been made in this office. In preparing the plate no doubtful observations have been used.

The usual method of measuring river discharge is similar to that described for the low water of 1899 at New Madrid, except that during high water a steamboat is used instead of a skiff. The method of making "flanking" discharge measurements is fully described in Report of Chief of Engineers for 1894, page 2820. Of recent years float observations have only been made as a check on meter results. The plat shows very plainly what large variations in discharge may be expected for the same gauge heights; an extreme case, that of Arkansas City, shows a variation for the same gauge height in two different years of 300,000 cubic feet per second, which would amount in twenty-four hours to a volume sufficient to cover an area of ten miles square, or 100 square miles, to a depth of 9.3 feet. When large variations, however, occur in the same year the cause is generally apparent, as, for instance, at Arkansas City in 1892, when the discharge decreased while the river continued to rise; this was plainly due to that part of the Arkansas River flood which reached the Mississippi above Arkansas City after the flood from the upper river had passed. The larger part of the Arkansas River flood of that year, however, escaped through the Auburn and other crevasses and passed down through the Tensas Basin before reaching the Mississippi. Where discharge observations happened to be in progress when the large crevasses occurred, and not too remote from them, the effect is very marked both on gauge and discharge; when the crevasse is below the stations it tends to lower the stage and at the same time increase the velocity, while at the stations below the crevasse this effect seems to be reversed. The combined effect of the new Morganza and Nita crevasses on the Red River Landing and Carrollton discharges in 1890 is a good example of this.

Space will not admit of giving here the details of each flood. The swamp flow through the great basins in 1882, 1883, and 1884 is stated in the Report of Chief of Engineers for 1885, pages 2575 to 2635. The efficiency of the levees has been so greatly increased since then that the flood of 1898, which read 49.4 feet on the Vicksburg gauge, was carried to the Gulf without a break in the levees; these levees would not, however, have withstood the flood of 1897, which read 52.48 feet on the Vicksburg gauge. The effect of the levees is undoubtedly to eventually enlarge the discharging capacity of the river, but as the effect of a crevasse is for the time being to lower the stage at that point, and thereby increase the slope from points immediately above it, causing increased velocity and discharge for a given stage, it is not fair to make deductions from the varying relations of different gauges in different years without also considering the actual measured discharges. A case in point is that of Red River Landing and Carrollton in 1882 and in 1897. At Red River Landing in the 1882 flood the discharges were carefully measured, and at the maximum stage of 48.5 feet on the gauge the discharge was over one and a half million cubic feet per second; in 1897 the discharge at a stage of 50.2 feet on the same gauge, or 1.7 feet greater, was a little over 1,250,000 cubic feet per second, or about 200,000 cubic feet per second less. The total slope between Red River Landing and Baton Rouge, the next gauge station below in 1882, was 2.98 feet greater in 1882 than it was in 1897, which seems to fully account for the greater discharge in 1882. The greater slope was probably caused by the large crevasses below Red River Landing in 1882; these had all been closed long before 1897.

In conclusion, it might be said that while the temporary effect of a crevasse is to increase the efficiency of the sections immediately above, as shown at Red River Landing, it also tends to retard the discharge at stations below, as shown at Carrollton in 1890; and that the closing of the crevasses and raising the levees has largely increased the discharging capacity of the river, as shown at Carrollton in 1897.

SCOUR AND FILL SURVEY.

A survey to determine the amount and character of changes in the bed of the river under varying conditions of stage was begun last August in the vicinity of New Madrid, Mo. (71 R), and is still in progress.

A preliminary shore line and bar survey was made early in September by triangulation and stadia and connected with the permanent marks of the general survey of the river. Thirty-one cross-section ranges were established and sounded and the bars profiled by leveling on lines of the sections; duplicate levels were also run on each bank over the reach. Two additional ranges, Nos. 32 and 33, were established at the lower end of the reach, but are not regarded as necessary and have not been used. The portion of the river covered by the survey extends from about a half mile above New Madrid to about a half mile below Watsons Landing, and includes nearly 6 miles of the river.

Since early in September the 31 cross sections have all been sounded about once each week; these soundings have been platted in chronological order for each sec-

tion, and the areas are now being measured with the planimeter for tabulation. All the cross-section areas will be referred to a common datum and the amount of scour or fill between the dates of observations deduced therefrom for each section. The soundings have been taken about 50 feet apart on the cross sections, the exact location of each being determined from shore by an observer with a transit instrument.

About the middle of November slope gauges were established on each bank of the river at intervals of about 1 mile, twelve gauges in all. These were read twice a day until February 16, 1900, when eight of the gauges were discontinued. Since then the remaining four have been read twice a day except Sundays.

During periods of rapid oscillations in the river stage very considerable work was necessitated in maintaining and resetting range targets and slope gauges.

A full report of methods and results of this survey will be submitted at the conclusion of the work.

OFFICE PUBLICATIONS.

The annual pamphlet of river stages has been prepared and printed. This publication gives the daily gauge readings at 34 stations on the Mississippi River and 25 stations on the principal tributaries for the year 1899, together with descriptions of the gauges and their bench marks; it contains about 115 pages. The monthly reports of operations have been prepared and printed; the proceedings of the commission, seventy-seventh to seventy-ninth sessions, inclusive, have been printed. The papers on the subjects of cost of bank protection, dredging operations in 1899, and changes in flood heights on the Lower Mississippi, submitted at the seventy-ninth session by the district officers and the secretary, have been printed pursuant to orders of the commission and issued in one pamphlet. Catalogues and card indexes of drawings, field notebooks, and manuscripts have been continued.

The following gentlemen have rendered efficient services in this division during part of the year: Messrs. C. M. Talbert, E. J. Thomas, E. E. Whitehead, and W. H. Henby, in computing and platting; and Mr. E. M. Hutchins in tabulating gauge records, etc.

Respectfully submitted.

KIVAS TULLY, *Assistant Engineer.*

Capt. MASON M. PATRICK,
Corps of Engineers, U. S. A.

TABLE No. 15.—*Highest and lowest gauge readings of 1899.*

MISSISSIPPI RIVER.

Station.	Distance from Cairo.	Elevation of gauge zero above Cairo datum plane.	Highest.					Lowest.				
			Prior to 1899.		1899.		Difference compared with previous highest.	Prior to 1899.		1899.		Difference compared with previous lowest.
			Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
	Miles above.	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Hastings, Minn	892.6	690.79	Apr. 30, 1881	18.00	June 18–20	11.3	— 6.70	Nov. 23, 1892	−0.70	Feb. 6–18	1.4	.....
										Dec. 17–18	1.8	+2.50
Winona, Minn	794.8	660.34	June 18, 1880	16.87	June 18–19	11.7	— 5.17	Dec. 30, 1889	−1.33	Feb. 4–6	1.9	.....
										Aug. 16–18	2.5	+3.83
North McGregor, Iowa	688.8	625.32	June 22, 1880	21.5	.....	.....	.....	Nov. 26, 1898	.1	Oct. 18–20	2.0	+1.9
Rock Island, Ill	509.2	562.37	June 27, 1892	19.4	June 25	11.9	— 7.5	Jan. 5–6, 1890	− .9	Dec. 22	.5	+1.4
Burlington, Iowa	427.6	531.25	May 18–19, 1888; June 30, 1892.	17.6	June 28	10.4	— 7.2	Dec. 4–5, 1895	−1.1	Dec. 27	− .9	+ .2
Nashville, Iowa	393.6	516.86	May 17–18, 1888	12.0	June 29	6.7	— 5.3	Jan. 7, 1890	− .5	Dec. 28	.3	+ .8
Hannibal, Mo	329.4	469.60	May 17, 1888	21.58	May 23	15.0	— 6.58	Jan. 9, 1890	−1.75	Dec. 30	−1.5	+ .25
Grafton, Ill	233.0	424.09	May 18, 1892	25.73	May 25	18.3	— 7.43	Dec. 9, 1895	− .9	Dec. 31	.8	+1.7
St. Louis, Mo	190.8	400.23	May 19, 1892	a35.95	Apr. 27	25.68	—10.27	Jan. 27, 1895	− .60	Dec. 31 *b*	− .79	− .19
Chester, Ill	115.5	361.30	May 21, 1892	31.2	.....do	21.4	— 9.8	Dec. 24–25, 1897	−1.9	Dec. 30	.1	+2.0
Cape Girardeau, Mo	54.5	324.97	Apr. 12–13, 1897	31.6	Apr. 27–28	26.0	— 5.6	Dec. 26–27, 1897	1.0	Feb. 3	3.6	.....
										Dec. 30	4.0	+3.0
Grays Point, Mo	48.0	321.28	May 22, 1892	35.00	Apr. 28	26.0	— 9.0	Dec. 31, 1880	.95	Dec. 31	4.0	+3.05
	Below.											
Belmont, Mo	21.3	286.85	Feb. 26, 1883	45.58	Apr. 4	42.0	— 3.58	Nov. 6–8, 1895	.05	Oct. 27	2.97	+2.92
Morrisson Landing, Mo. *c*	69.0	275.80	Feb. 24, 1884	41.50	.....	.....	.....	Nov. 11–14, 1879	− .17	.....	.....	.....
New Madrid, Mo	70.3	275.72	Mar. 29, 1897	40.27	Mar 30	36.10	— 4.17	Nov. 6–8, 1895	.55	Oct. 28	2.60	+2.05
Cottonwood Point, Mo	122.5	250.67	Mar. 21–23, 1897	39.35	Mar. 30; Apr. 3, 4, 7, 8.	36.45	— 2.90	Nov. 5–8, 1895	−3.35	Oct. 30–Nov. 1	− .2	+3.15
Fulton, Tenn	175.4	228.55	Apr. 10, 1898	38.30	Apr. 7	34.90	— 3.40	Nov. 7–8, 1895	.16	Oct. 30	2.63	+2.47
Memphis, Tenn	230.0	203.97	Mar. 20, 1897	37.66	Apr. 1–11	35.20	— 2.46	Nov. 6–9, 1895	−2.65	Oct. 31–Nov. 1	.54	+3.19
Mhoon Landing, Miss	276.3	181.48	Apr. 4, 1897	41.60	Apr. 7–14	38.0	— 3.60	Nov. 6–11, 1895	−7.80	Oct. 30–Nov. 2	−4.8	+3.00
Helena, Ark	306.5	161.98	.....do	51.75	Apr. 12–15	46.75	— 5.00	Nov. 8–9, 1895	−3.00	Nov. 1–2	1.70	+4.70
Sunflower Landing, Miss	352.7	147.08	Mar. 27, 1897	47.17	Apr. 12–16	44.3	— 2.87	Nov. 12–14, 1895	−1.50	Nov. 1–3	2.76	+4.26
Mouth of White River, Ark	393.2	128.73	Mar. 29, 1897	52.42	Apr. 15–16	48.49	— 3.93	Dec. 28, 1872	.00	Nov. 3	4.70	+4.70
Arkansas City, Ark	438.3	116.44	.....do	51.9	Apr. 15–20	48.6	— 3.3	Nov. 9–10, 1895	−3.6	Nov. 2–5	1.00	+4.6
Greenville, Miss	478.3	108.00	.....do	46.75	Apr. 17–20	43.00	— 3.75	Nov. 10–11, 1895	−2.55	Nov. 3–5	1.20	+3.75
Lake Providence, La	542.3	89.62	Mar. 30, 1897	44.54	Apr. 16–21	41.65	— 2.89	Nov. 17, 1895	−5.30	Nov. 5	−2.15	+3.15
Vicksburg, Miss	599.3	66.04	Apr. 16, 1897	52.48	Apr. 17–23	47.30	— 5.18	Nov. 13–14, 1895	−6.5	Nov. 6	−1.58	+4.92

St. Joseph, La	648.3	52.74	Apr. 17, 1897	47.85	Apr. 21–21	43.25	— 4.60	Nov. 13, 1865	9.3	Nov. 7, 8	5.20	+4.10
Natchez, Miss	700.3	36.89	May 2, 1897	49.82	Apr. 23–25	40.15	— 3.67	Nov. 13–15, 1866	.85	Nov. 3–4	2.00	+3.45
Red River Landing, La	765.3	23.85	May 14–15, 1897	50.20	Apr. 22–27	43.30	— 6.90	Nov. 14, 1866	.60	Nov. 3–4	1.00	+1.60
Bayou Sara, La	799.8	23.95	May 13–15, 1897	43.7	Apr. 21–26	38.7	— 7.0	Nov. 16, 1895	—2.7	Nov. 8	—1.4	+1.30
Baton Rouge, La	833.3	20.06	....do	40.65	Apr. 21–28	33.70	— 6.95	Nov. 14, 1894	.45	Nov. 3, 5	1.20	+ .75
Plaquemine, La	854.1	21.06	May 13–17, 1897	36.25	Apr. 21, 25	30.1	— 6.15	....do	— .94	Nov. 4	.04	+ .98
Donaldsonville, La	895.4	19.48	May 13, 1897	32.75	Apr. 21	27.50	— 5.25	Nov. 11, 1894	1.00	Oct. 18	2.15	+1.15
College Point, La	904.5	21.24	May 15, 1897	27.95	....do	23.15	— 4.80	Nov. 14, 1894	— .91	Nov. 5	— .89	+ .52
Carrollton, La	957.0	20.91	May 13, 1897	19.17	....do	16.00	— 3.17	Dec. 27, 1872	—1.60	Nov. 4	.00	+1.60
Fort Jackson, La	1,039.0	19.26	Apr. 22, 23, 29; May 14, 16, 1897.	7.2	....do	6.98	— 0.22	Dec. 7, 1893; Nov. 12, 14, 1894.	.3	Dec. 4	.88	+ .58

a High water of June 28, 1844 as, reported, would read 41.4 feet.
b River at St. Louis continued to fall until January 2, 1900, when the stage was 2.52 feet below the zero of the gauge.
c Gauge transferred to New Madrid in 1868.

TABLE No. 15.—*Highest and lowest gauge readings of 1899*—Continued.

TRIBUTARIES OF MISSISSIPPI RIVER AND THE ATCHAFALAYA.

River.	Station.	Approximate distance of station from—		Elevation of gauge zero above Cairo datum plane.	Highest.					Lowest.				
					Prior to 1899.		1899.		Difference compared with previous highest.	Prior to 1899.		1899.		Difference compared with previous lowest.
					Date.	Gauge reading.	Date.	Gauge reading.		Date.	Gauge reading.	Date.	Gauge reading.	
			Miles.	*Feet.*		*Feet.*		*Feet.*	*Feet.*		*Feet.*		*Feet.*	*Feet.*
Arkansas	Little Rock, Ark	Mouth	176	241.53	May 21, 1892	31.20	May 11	25.90	— 5.30	Oct. 23–24, 1879	— 1.00	Oct. 26–Nov. 2	3.50	+4.50
Do. *a*	Pine Bluff, Ark	do	110	200.34	May 22, 1892	30.50				Nov. 20–23, 1887	— .40			
Atchafalaya	Barbre Landing, La	Head	0	24.17	May 13–14, 1897	50.95	Apr. 25–28	41.60	— 9.35	Oct. 26, 1897	— 1.77	Nov. 5	?—1.30	+ .47
Do. *a*	Simmesport, La	do	4	24.17	May, 1897	49.22				Nov. 8, 1891	— 1.60			
Do	West Melville, La	do	27	20.17	Mar. 31, 1882	37.00	Apr. 21-May 1	33.4	— 3.6	Nov. 12–13, 1894	1.0	Nov. 6–7	1.6	+ .6
Cumberland	Nashville, Tenn	Cairo	234		Jan. 22, 1882	55.30	Feb. 11	40.60	—14.70	Oct. 15–16, 1878	— .40	Oct. 10	.55	+ .95
Illinois	Peoria, Ill	Mouth	160		May 9, 1892	21.9	Mar. 22	15.1	— 6.8	Oct. 7, 1890	2.6	Aug. 22–24, 27–29.	3.4	+ .8
Do. *a*	Beardstown, Ill	do	86	444.26	1882	21.3				Aug. 11–12, 1887	.00			
Missouri	Coles Creek, Mo	do	107	433.97	May 15, 1892	96.76	Apr. 25–26	90.6	— 6.16	Dec. 24, 1897	70.7	Dec. 31	71.9	+1.2
Do	Hermann, Mo	do	103	502.17	June, 1844	35.6	Apr. 26–27	18.9	—16.7	Dec. 22, 1897	— .6	Feb. 3 Dec. 31	1.6 2.3	+2.9
Ohio	Cincinnati, Ohio	do	504	447.62	Feb. 14, 1884	71.06	Mar. 8	57.3	—13.76	Sept. 18, 1881	1.92	Nov. 1–2	3.4	+1.48
Do	Louisville (upper), Ky.	do	364	419.76	Feb. 16, 1884	46.60	Mar. 10	32.80	—13.80	Sept. 10–14, 18–22, 1881; Nov. 14–16, 1895.	1.70	Sept. 5–6	2.20	+ .50
Do	Louisville (lower), Ky.	do	364	392.85	do	72.00	do	58.30	—13.70	Oct. 17–18, 1872	1.60	Nov. 2–3	2.90	+1.30
Do	Paducah, Ky	do	45	?308.40	Feb. 23, 1884	54.25	Apr. 4–5	43.8	—10.45	Oct. 30–Nov. 4, 1895.	— .7	Oct. 13–16, Nov. 5–10.	.5	+1.2
Do	Cairo, Ill	do	1	290.84	Feb. 27, 1883	52.17	Apr. 2	46.24	— 5.93	Dec. 24, 1871	— 1.00	Oct. 16	2.98	+3.98
Ouachita	Camden, Ark	Mouth Red River.	325	91.38	May 12, 1882	46.0	Jan. 18	39.10	— 6.90	Aug. 29–30, 1887	1.80	Oct. 20	2.35	+ .55
Do	Monroe, La	do	175	51.22	1882	48.60	Feb. 5–7	32.3	—16.30	Sept. 24–Oct. 31, 1897.	.0	Sept. 28–Nov. 27.	.0	.0
Red	Fulton, Ark	Mouth	508	244.78	July 17, 1876	35.75	Nov. 28	26.60	— 9.15	Oct. 20–22, 1896	.10	Sept. 21	2.40	+2.30
Do	Garland, Ark	do	450	223.44	Mar. 24, 1894	28.50	do	26.60	— 1.90	Sept. 22–25, 1896	— .20	Oct. 31-Nov. 1	.95	+1.15
Do	Shreveport, La	do	320	161.27	May 28, 1892	35.70	Jan. 24	15.60	—20.10	Dec. 2–4, 1894	— 5.50	Oct. 28-Nov. 3	— .70	+4.80
Do	Alexandria, La	do	110	64.46	June 12–13, 1892	38.25	Jan. 27	18.20	—20.05	Sept. 29, 1881	— 3.7	Nov. 5–6	— 2.55	+1.15
St. Francis	Bridge, St. L., I. M. & S. Ry.	do	194		Apr. 4–6, 1897	41.6	Apr. 11–15	30.3	—11.3	Nov. 15–25, 1897	.3	Oct. 24–28, 31–Nov. 20.	.5	+ .2
Do. *a*	Wittsburg, Ark	do	180		Apr. 28, 1886	42.02				Oct. 27–31, Nov. 10–14, 1892.	— 3.60			

Tennessee	Chattanooga, Tenn	Cairo	475	651.90	Mar. 1, 1875	54.00	Mar. 22	40.0	— 14.0	Sept. 11–14, 1861, and 19, 1843.	.10	Oct. 7, 27–28, Nov. 22.	.8	+ .8
Do	Florence, Ala	do	275	418.08	Mar. 19, 1897	32.20	Mar. 20	26.20	— 7.0	Oct., 1872, Sept. 18, 1878.	— .75	Sept. 26, Oct. 10, 29–Nov. 6.	— .10	+ .05
Wabash	Mount Carmel, Ill	do	190	397.81	Aug. 7, 1875	26.3	Jan. 23	19.5	— 8.8	Nov. 7–28, 1895	— .2	Sept. 30–Oct. 18.	.3	+ .5
White	Jacksonport, Ark	Mouth	360	.....	Mar. 14, 1890	33.35	May 12	29.0	— 4.35	Dec. 24, 1872	— 1.10	Oct. 7–10	.40	+1.50
Do	Clarendon, Ark	do	194	158.9	Mar. 20, 1890	36.63	May 21	29.55	— 7.08	Nov. 22, 1887	4.07	Oct. 9–16	5.75	+1.68
Yazoo	Yazoo City, Miss	do	65	98.84	1882	36.50	Apr. 9–14	25.8	—10.70	1876	4.80	Dec. 24–26	6.3	—2.00

a Discontinued

TABLE No. 16.—*Low-water slope, Mississippi River, Cairo to Fort Jackson, 1899.*

No. of gauge.	Locality of station.	Bank.	Distance from Cairo.	Observed elevation of water surface, Memphis datum.	Correction for change of stage.	Corrected elevation of water surface, Memphis datum.	Fall between stations.	Distance between stations.	Slope per mile.	Time of observation.		Lowest gauge reading.	
										Day.	Hour.	Date.	Feet.
			Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Miles.*	*Feet.*	1899.		1899.	
	Cairo gauge		0.0	282.13	1.40	280.73				Oct. 3	8 a. m.	Oct. 16	2.98
182		L.	4.5	a 279.67	1.42	278.25	2.48	4.5		....do...	10 a. m.		
181		L.	8.8	280.29	1.43	278.86	− .61	4.3	0.213	....do...	1 p. m.		
180		R.	13.0	279.42	1.45	277.97	.89	4.2	.212	Oct. 4	7 a. m.		
179		R.	17.9	278.32	1.46	276.86	1.11	4.9	.227	....do...	9 a. m.		
	Belmont gauge	R.	21.3	278.17	1.47	276.70	.16	3.4	.047	....do...	12 m.	Oct. 27	2.97
178		L.	27.5	275.97	1.42	274.55	2.15	6.2	.347	....do...	3 p. m.		
177		L.	34.2	273.00	1.36	271.64	2.91	6.7	.434	Oct. 5	8 a. m.		
176		R.	38.8	272.16	1.33	270.83	.81	4.6	.176	....do...	10 a. m.		
175		R.	44.4	271.47	1.29	270.18	.65	5.6	.116	....do...	11 a. m.		
174		L.	49.5	270.92	1.24	269.68	.50	5.1	.098	....do...	1 p. m.		
173		L.	54.3	269.92	1.21	268.71	.97	4.8	.202	....do...	2 p. m.		
172		L.	59.4	268.39	1.16	267.23	1.48	5.1	.290	....do...	3 p. m.		
171		R.	64.5	267.77	1.13	266.64	.59	5.1	.116	....do...	5 p. m.		
	New Madrid gauge	R.	70.3	266.27	1.08	265.19	1.45	5.8	.250	Oct. 6	8 a. m.	Oct. 28	2.60
170		L.	73.4	264.73	1.08	263.65	1.54	3.1	.497	....do...	11 a. m.		
169		R.	78.9	262.99	1.09	261.90	1.75	5.5	.318	....do...	1 p. m.		
168		L.	86.7	256.22	1.10	255.12	6.78	7.8	.869	....do...	5 p. m.		
167		R.	90.0	254.26	1.10	253.16	1.96	3.3	.594	Oct. 7	10 a. m.		
166		L.	95.2	250.91	1.11	249.80	3.36	5.2	.646	....do...	11 a. m.		
165		L.	99.1	249.22	1.11	248.11	1.69	3.9	.433	....do...	12 m.		
164		R.	104.1	245.66	1.12	244.54	3.57	5.0	.714	....do...	1 p. m.		
163		L.	109.3	242.97	1.12	241.85	2.69	5.2	.517	....do...	4 p. m.		
162		L.	114.0	241.67	1.13	240.54	1.31	4.7	.279	....do...	5 p. m.		
161		R.	119.3	240.29	1.14	239.15	1.39	5.3	.262	Oct. 9	9 a. m.		
	Cottonwood Point gauge	R.	122.5	238.48	1.14	237.34	1.81	3.2	.566	....do...	11 a. m.	Oct. 30–Nov. 1	−0.2
160		L.	127.4	235.86	1.10	234.76	2.58	4.9	.527	....do...	3 p. m.		
159		L.	131.6	233.51	1.08	232.43	2.33	4.2	.555	....do...	5 p. m.		
158		L.	135.1	230.86	1.05	229.81	2.62	3.5	.749	Oct. 10	8 a. m.		
157		R.	140.0	230.79	1.01	229.78	.03	4.9	.006	....do...			
156		L.	146.3	229.29	.97	228.32	1.46	6.3	.232	....do...	10 a. m.		
155		R.	153.1	227.49	.92	226.57	1.75	6.8	.257	....do...	12 m.		
154		R.	158.0	225.45	.88	224.57	2.00	4.9	.408	....do...	1 p. m.		
153		L.	162.7	222.29	.85	221.44	3.13	4.7	.666	....do...	3 p. m.		
152		R.	167.8	220.67	.81	219.86	1.58	5.1	.310	....do...			
151		R.	172.8	218.77	.77	218.00	1.86	5.0	.372	Oct. 11			
	Fulton gauge	L.	175.4	218.81	.76	218.05	− .05	2.6	− .019	....do...	11 a. m.	Oct. 30	2.63
150		L.	180.1	215.30	.73	214.57	3.48	4.7	.740	....do...	2 p. m.		
149		L.	186.1	211.75	.70	211.05	3.52	6.0	.587	....do...	3 p. m.		

148		L.	192.6	200.14	.61	200.48	5.67	6.5	.867	....do....	7 p. m.		
147		L.	197.1	201.68	.64	201.24	4.24	4.5	.942	Oct. 12	7 a. m.		
146		R.	203.5	199.17	.60	198.57	2.67	6.4	.417	....do....	8 a. m.		
145		R.	207.8	198.71	.58	198.13	.41	4.3	.102	....do....	11 a. m.		
144		L.	212.8	198.00	.55	197.45	.68	5.0	.136	....do....	1 p. m.		
143			220.4	194.42	.51	193.91	3.54	3.7	.957	....do....	2 p. m.		
142		L.	225.1	192.86	.49	192.37	1.54	4.7	.328	....do....			
	Memphis gauge	L.	230.0	b 191.84	.46	191.38	.99	4.9	.202	Oct. 13	4 p. m.	Oct. 31-Nov. 1	0.54
141		L.	235.2	187.97	.45	187.52	3.86	5.2	.742	Oct. 14	....do....		
140			239.6	185.73	.44	185.29	2.23	3.3	.676	....do....	5 p. m.		
139		L.	245.2	180.31	.43	179.88	5.41	5.6	.966	Oct. 15	11 a. m.		
138		R.	249.6	179.84	.42	179.42	.46	4.4	.105	....do....	2 p. m.		
137		R.	256.5	175.95	.40	175.55	3.87	6.9	.561	....do....	4 p. m.		
136		R.	261.2	173.30	.39	172.91	2.64	4.7	.562	Oct. 16	6 a. m.		
135		L.	266.7	172.33	.38	171.95	.96	5.5	.175	....do....	9 a. m.		
134		L.	271.0	169.94	.37	169.57	2.38	4.3	.535	....do....	10 a. m.		
	Moon Landing gauge	L.	276.3	168.91	.36	168.55	6.02	5.3	1.136	....do....	3 p. m.	Oct. 30-Nov. 2	4.8
133		R.	281.5	162.74	.37	162.37	1.18	5.2	.227	Oct. 17	8 a. m.		
132		R.	284.2	162.04	.39	161.65	.72	2.7	.267	....do....	11 a. m.		
131		L.	289.5	158.35	.41	157.94	3.71	5.3	.700	....do....	1 p. m.		
130		L.	293.6	156.97	.42	156.55	1.39	4.1	.339	....do....	3 p. m.		
129		R.	297.6	a 152.49	.44	152.05	4.50	4.0	.....	....do....	4 p. m.		
128		R.	301.4	152.64	.45	152.19	−.14	3.8	.559	Oct. 18	8 a. m.		
	Helena gauge	R.	306.5	b 151.05	.47	150.58	1.61	5.1	.316	....do....	4 p. m.	Nov.1-2	1.70
127		L.	312.8	148.94	.45	148.49	2.09	6.3	.332	Oct. 19	8 a. m.		
126		R.	318.2	147.02	.44	146.58	1.91	5.4	.354	....do....	10 a. m.		
125		R.	324.7	145.68	.43	145.25	1.33	6.5	.205	....do....	1 p. m.		
124		L.	329.2	145.52	.41	145.11	.14	4.5	.031	....do....	2 p. m.		
123		R.	334.6	142.07	.40	141.67	3.44	5.4	.637	....do....	3 p. m.		
122		L.	339.0	140.57	.39	140.18	1.49	4.4	.339	....do....	4 p. m.		
121		R.	342.9	140.17	.38	139.79	.39	3.9	.100	....do....	5 p. m.		
120		R.	346.6	140.16	.37	139.79	.00	3.7	.000	Oct. 20	7 a. m.		
	Sunflower Landing gauge	L.	352.7	137.07	.36	136.71	3.08	6.1	.505	....do....	10 a. m.	Nov.1-3	2.76
119		L.	357.0	136.59	.36	136.23	.48	4.3	.112	....do....	1 p. m.		
118		R.	362.1	133.00	.37	132.63	3.60	5.1	.706	....do....	3 p. m.		
117		R.	366.7	131.66	.37	131.29	1.34	4.6	.291	....do....	4 p. m.		
116		L.	371.7	128.00	.38	127.62	3.67	5.0	.734	Oct. 21	7 a. m.		
115		L.	378.7	127.31	.39	126.92	.70	7.0	.100	....do....	10 a. m.		
114		R.	383.6	124.63	.39	124.24	2.68	4.9	.547	....do....	11 a. m.		
113		R.	389.6	121.56	.40	121.16	3.08	6.0	.513	....do....	1 p. m.		
	Mouth of White River gauge	R.	393.2	b 120.70	.40	120.30	.86	3.6	.239	....do....	4 p. m.	Nov. 3	4.70
112		L.	398.8	119.59	.39	119.20	1.10	5.6	.196	....do....	3 p. m.		
111		R.	401.7	119.09	.38	118.71	.49	2.9	.169	....do....	4 p. m.		
110		R.	407.8	117.68	.37	117.31	1.40	6.1	.230	Oct. 23	7 a. m.		
109		R.	411.9	117.33	.37	116.96	.35	4.1	.085	....do....	8 a. m.		
108		L.	416.7	115.68	.36	115.32	1.64	4.8	.342	....do....	10 a. m.		
107		L.	421.7	113.51	.35	113.16	2.16	5.0	.432	....do....	12 m.		
106		R.	427.1	110.29	.34	109.95	3.21	5.4	.594	....do....	2 p. m.		
105		R.	432.4	108.77	.34	108.43	1.52	5.3	.287	....do....	4 p. m.		

a Reject; evidently too low.

b From gauge records.

TABLE No. 16.—*Low-water slope, Mississippi River, Cairo to Fort Jackson, 1899*—Continued.

No. of gauge.	Locality of station.	Bank.	Distance from Cairo.	Observed elevation of water surface, Memphis datum.	Correction for change of stage.	Corrected elevation of water surface, Memphis datum.	Fall between stations.	Distance between stations.	Slope per mile.	Time of observation.		Lowest gauge reading.	
										Day.	Hour.	Date.	Feet.
			Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Miles.*	*Feet.*	1899.		1899.	
	Arkansas City gauge	R.	438.3	104.64	0.33	104.31	4.12	5.9	0.698	Oct. 24	10 a. m.	Nov.2–5	1.00
104		L.	444.3	103.83	.34	103.49	.82	6.0	.137	....do...	2 p. m.		
103		R.	449.5	103.28	.34	102.94	.55	5.2	.106	....do...	3 p. m.		
102		R.	453.0	102.78	.35	102.43	.51	3.5	.146	....do...	5 p. m.		
101		L.	459.5	100.86	.36	100.50	1.93	6.5	.297	Oct. 25	7 a. m.		
100		R.	463.7	100.85	.37	100.48	.02	4.2	.005	....do...	9 a. m.		
99		R.	467.3	98.81	.37	98.44	2.04	3.6	.567	....do...	10 a. m.		
98		R.	473.4	97.71	.38	97.33	1.11	6.1	.182	....do...	12 m.		
	Greenville gauge	L.	478.3	96.46	.39	96.07	1.26	4.9	.257	....do...	4 p. m.	Nov.3–5	1.20
97		L.	482.6	95.73	.39	95.34	.73	4.3	.170	Oct. 26	9 a. m.		
96		R.	486.7	93.71	.40	93.31	2.03	4.1	.495	....do...	11 a. m.		
95		R.	489.8	90.71	.40	90.31	3.00	3.1	.968	....do...	1 p. m.		
94		R.	495.2	89.44	.41	89.03	1.28	5.4	.237	....do...	4 p. m.		
a 93		L.	500.9	89.13	.41	88.72	.31	5.7	.054	Oct. 27	9 a. m.		
92		R.	505.6	87.18	.42	86.76	1.96	4.7	.417	....do...	12 m.		
91		R.	510.7	86.02	.42	85.60	1.16	5.1	.227	....do...	2 p. m.		
a 90		R.	516.6	82.75	.43	82.32	3.28	5.9	.557	....do...	5 p. m.		
89		R.	522.8	82.02	.43	81.59	.73	4.2	.174	Oct. 28	7 a. m.		
88		L.	526.2	80.88	.44	80.44	1.15	3.4	.338	....do...	9 a. m.		
87		R.	531.5	78.49	.44	78.05	2.39	5.3	.451	....do...	11 a. m.		
86		R.	537.3	75.87	.45	75.42	2.63	5.8	.453	....do...	1 p. m.		
	Lake Providence gauge	R.	542.3	a74.79	.45	74.34	1.08	5.0	.216	....do...	4 p. m.	Nov. 5	−2.15
85		R.	546.5	71.54	.45	71.09	3.25	4.2	.774	....do...	4 p. m.		
84		L.	552.3	70.63	.46	70.17	.92	5.8	.159	Oct. 30	8 a. m.		
83		R.	556.3	70.49	.46	70.03	.14	4.2	.033	....do...	10 a. m.		
82		R.	561.3	68.08	.46	67.62	2.41	4.0	.602	....do...	11 a. m.		
81		R.	567.8	64.20	.46	63.74	3.88	6.5	.597	....do...	2 p. m.		
80		R.	573.8	60.68	.46	60.22	3.52	6.0	.587	....do...	4 p. m.		
79		R.	578.4	59.80	.47	59.33	.89	4.6	.198	Oct. 31	8 a. m.		
a 78		R.	583.3	58.60	.47	58.13	1.20	4.9	.245	....do...	10 a. m.		
77		R.	588.7	55.07	.47	54.60	3.53	5.4	.654	....do...	12 m.		
76		R.	593.4	53.04	.47	52.57	2.03	4.7	.432	....do...	1 p. m.		
	Vicksburg gauge	L.	599.3	a51.81	.48	51.33	1.24	5.9	.210	....do...	4 p. m.	Nov. 6	−1.58
75		R.	602.6	50.82	.46	50.36	.97	3.3	.294	Nov. 1	9 a. m.		
74		L.	608.1	50.66	.43	50.23	.13	5.5	.024	....do...	11 a. m.		
73		R.	612.7	48.63	.40	48.23	2.00	4.6	.435	....do...	1 p. m.		
72		L.	617.3	44.52	.38	44.14	4.09	4.6	.889	....do...	8 p. m.		
71		R.	621.5	41.00	.35	40.65	3.49	4.2	.831	Nov. 2	11 a. m.		
70		L.	627.8	39.38	.32	39.01	1.64	6.3	.260	....do...	1 p. m.		

69		R.	652.9	38.78	.29	38.49	.61	5.1	.197	....do....	3 p. m.	.....	.....
68		L.	638.3	37.94	.23	37.68	.81	5.4	.150	....do....	5 p. m.	.....	.....
67		L.	643.0	36.56	.23	36.33	1.35	4.7	.287	Nov. 3	8 a. m.	.....	.....
	St. Joseph gauge	R.	648.3	34.61	.20	34.41	1.92	5.3	.362	....do....	10 a. m.	Nov. 5–6	−5.20
66		R.	655.2	33.81	.17	33.64	.77	6.9	.112	....do....	4 p. m.	.....	.....
65		R.	659.8	31.04	.15	30.89	2.75	4.6	.598	Nov. 4	8 a. m.	.....	.....
64		R.	664.3	30.71	.14	30.57	.32	4.5	.071	... do...	11 a. m.	.....	.....
63		L.	680.9	30.04	.12	29.92	.65	4.7	.138	....do....	.....	.....	.....
a 62		L.	686.4	29.63	.10	29.53	.39	5.5	.071	....do....	4 p. m.	.....	.....
61		R.	691.5	28.91	.08	28.83	.70	5.1	.137	....do....	5 p. m.	.....	.....
60		R.	694.0	28.31	.07	28.24	.59	2.5	.236	Nov. 5	11 a. m.	.....	.....
	Natchez gauge	L.	700.3	a 26.41	.05	26.36	1.88	6.3	.298	....do....	8 a. m.	Nov. 7–8	2.60
59		L.	705.4	b 27.41	.06	27.36	−1.00	5.1	.....	Nov. 8	1 p. m.	.....	.....
58		L.	711.1	22.46	.07	22.39	3.97	5.7	.275	....do....	4 p. m.	.....	.....
57		L.	716.2	19.80	.09	19.71	2.68	5.1	.525	Nov. 9	9 a. m.	.....	.....
56		R.	720.4	18.86	.10	18.76	.95	4.2	.226	....do....	1 p. m.	.....	.....
55		R.	725.2	17.09	.11	16.98	1.78	4.8	.371	....do....	2 p. m.	.....	.....
54		R.	730.7	16.25	.12	16.13	.85	5.5	.155	....do....	5 p. m.	.....	.....
53		R.	737.6	15.74	.13	15.61	.52	6.9	.075	Nov. 10	8 a. m.	.....	.....
52		L.	742.6	14.78	.15	14.63	.98	5.0	.196	....do....	10 a. m.	.....	.....
a 51		R.	747.3	14.53	.16	14.37	.26	4.7	.055	....do....	12 m.	.....	.....
50		L.	751.5	14.53	.17	14.36	.01	4.2	.002	....do....	3 p. m.	.....	.....
49		R.	755.9	13.98	.18	13.80	.56	4.4	.127	....do....	4 p. m.	.....	.....
48		L.	760.9	13.73	.19	13.54	.26	5.0	.052	....do....	5 p. m.	.....	.....
	Red River Landing gauge	R.	765.3	a 12.57	.20	12.37	1.17	4.4	.266	....do....	4 p. m.	Nov. 3–4	1.00
47		R.	769.2	12.58	.....	.....	.....	3.9	.....	Nov. 11	4 p. m.	.....	.....
46		L.	772.5	12.24	.....	.....	.....	3.3	.....	Nov. 13	7 a. m.	.....	.....
45		R.	779.6	11.24	.....	.....	.....	7.1	.....	....do....	8 a. m.	.....	.....
44		R.	784.9	10.80	.....	.....	.....	5.3	.....	....do....	10 a. m.	.....	.....
43		R.	790.5	10.52	.....	.....	.....	5.6	.....	....do....	11 a. m.	.....	.....
42		R.	794.5	10.16	.....	.....	.....	4.0	.....	....do....	12 m.	.....	.....
	Bayou Sara gauge	L.	799.8	9.76	.....	.....	.....	5.3	.....	....do....	3 p. m.	Nov. 3	−1.40
41		R.	803.6	9.56	.....	.....	.....	3.8	.....	Nov. 14	12 m.	.....	.....
40		R.	808.0	9.31	.....	.....	.....	4.4	.....	....do....	2 p. m.	.....	.....
39		R.	812.5	9.20	.....	.....	.....	4.5	.....	....do....	3 p. m.	.....	.....
38		R.	817.4	8.95	.....	.....	.....	4.9	.....	....do....	5 p. m.	.....	.....
37		R.	822.6	9.65	.....	.....	.....	5.2	.....	Nov. 15	8 a. m.	.....	.....
36		R.	828.4	9.27	.....	.....	.....	5.8	.....	....do....	11 a. m.	.....	.....
	Baton Rouge gauge	L.	833.3	a 8.78	.....	.....	.....	4.9	.....	....do....	4 p. m.	Nov. 3–5	1.20
35		L.	839.4	8.66	.....	.....	.....	6.1	.....	....do....	4 p. m.	.....	.....
34		L.	844.1	9.35	.....	.....	.....	4.7	.....	Nov. 16	9 a. m.	.....	.....
33		L.	850.0	8.97	.....	.....	.....	5.9	.....	....do....	10 a. m.	.....	.....
	Plaquemine gauge	R.	854.1	8.70	.....	.....	.....	4.1	.....	....do....	1 p. m.	Nov. 4	0.04
32		L.	859.9	8.52	.....	.....	.....	5.8	.....	....do....	4 p. m.	.....	.....
31		L.	864.8	8.35	.....	.....	.....	4.9	.....	....do....	5 p. m.	.....	.....
30		R.	869.9	9.44	.....	.....	.....	5.1	.....	Nov. 17	8 a. m.	.....	.....
29		L.	874.3	9.44	.....	.....	.....	4.4	.....	....do....	9 a. m.	.....	.....
28		R.	880.0	9.25	.....	.....	.....	5.7	.....	....do....	10 a. m.	.....	.....
	Donaldsonville gauge	R.	885.4	a 9.10	.....	.....	.....	5.4	.....	....do....	8 a. m.	Oct. 18	2.15
27		L.	889.8	9.14	.....	.....	.....	4.4	.....	....do....	11 a. m.	.....	.....
26		R.	895.8	8.67	.....	.....	.....	6.0	.....	....do....	1 p. m.	.....	.....

a From gauge records.

b Reject; evidently too high.

TABLE No. 16.—*Low-water slope, Mississippi River, Cairo to Fort Jackson, 1899*—Continued.

No. of gauge.	Locality of station.	Bank.	Distance from Cairo.	Observed elevation of water surface, Memphis datum.	Correction for change of stage.	Corrected elevation of water surface, Memphis datum.	Fall between stations.	Distance between stations.	Slope per mile	Time of observation.		Lowest Gauge reading.	
										Day.	Hour.	Date.	Feet.
			Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Miles.*	*Feet.*	1899.		1899.	
25		R.	900.3	8.39				4.5		Nov. 17	2 p. m.		
	College Point gauge	L.	904.5	8.52				4.2		....do...	4 p. m.	Nov. 5	—0.39
24		L.	910.5	8.81				6.0		Nov. 18	8 a. m.		
23		R.	914.7	8.49				4.2		....do...	9 a. m.		
22		R.	919.7	8.32				5.0		....do...	10 a. m.		
21		R.	925.5	8.19				5.8		....do...	11 a. m.		
20		L.	930.5	8.09				5.0		....do...	12 m.		
19		R.	934.2	8.01				3.7		....do...	1 p. m.		
18		L.	937.8	7.94				3.6		....do...	2 p. m.		
17		R.	943.5	8.01				5.7		....do...	3 p. m.		
16		L.	948.0	8.16				4.5		....do...	4 p. m.		
15		L.	953.0	8.20				5.0		....do...	5 p. m.		
	Carrollton gauge	L.	957.0	a8.18				4.0		....do...	4 p. m.	Nov. 4	0.06
	Canal Street gauge	L.											
14		L.	968.0	8.83				11.0		Nov. 21	8 a. m.		
13		L.	973.5	8.60				5.5		....do...	9 a. m.		
12		R.	979.2	8.49				5.7		....do...	10 a. m.		
11		L.	983.5	8.31				4.3		....do...	11 a. m.		
10		L.	989.2	8.09				5.7		....do...	12 m.		
9		R.	993.0	8.01				3.8		....do...	1 p. m.		
a8		L.	998.8	8.26				5.8		....do...	2 p. m.		
7		R.	1,003.8	8.44				5.0		....do...	3 p. m.		
6		R.	1,008.2	8.51				4.4		....do...			
5		R.	1,013.0	9.25				4.8		Nov. 22	7 a. m.		
4		R.	1,019.0	8.70				6.0		....do...	8 a. m.		
3		L.	1,023.8	8.61				4.8		....do...	9 a. m.		
2		R.	1,029.0	8.47				5.2		....do...	10 a. m.		
1		R.	1,034.0	8.24				5.0		....do...	11 a. m.		
	Fort Jackson gauge	R.	1,039.0	8.23				5.0		....do...	12 m.	Dec. 4	0.88

a From gauge records.

NOTES.—Small reverse slopes shown in table evidently due to errors in leveling or disturbance of bench marks.
Slope not computed below Red River Landing on account of tidal effect.
Cairo reading, 8 a. m., October 27, used in this table = 3.04.
Red River Landing reading, 8 a. m., November 8, used in this table = 1.65.

TABLE No. 17.—*Results of tidal observations at Biloxi Bay compared with those of Port Eads and East Bay.*

Period.	Biloxi.			Port Eads mean.	East Bay mean.	Differences, Biloxi and—	
	High.	Low.	Mean.			Port Eads.	East Bay.
1892			6.137	2.703		3.434	
1894			6.037	2.706		3.331	
1895-96.							
Dec. 10 to Jan. 6	6.681	4.581	5.631	2.866	2.542	2.765	3.089
1896.							
Jan. 7 to Feb. 2	6.749	4.662	5.706	3.131	2.646	2.575	3.060
Feb. 3 to Feb. 29	6.522	4.522	5.522	3.006	2.458	2.516	3.064
Mar. 1 to Mar. 28	6.501	4.608	5.554	2.977	2.406	2.577	3.148
Mar. 29 to Apr. 24	6.827	5.140	5.984	3.310	2.658	2.674	3.326
Apr. 25 to May 22	7.144	5.454	6.299	3.402	2.900	2.897	3.399
May 23 to June 18	7.408	5.474	6.440	3.632	3.187	2.808	3.253
June 19 to July 15	7.264	5.301	6.282	3.418	2.965	2.864	3.317
July 16 to Aug. 11	6.913	5.108	6.008	3.198	2.760	2.810	3.248
Aug. 12 to Sept. 8	6.896	5.370	6.133	3.363	2.962	2.770	3.171
Sept. 9 to Oct. 5	7.049	5.665	6.357	3.524	3.218	2.833	3.139
Oct. 6 to Nov. 2	7.186	5.584	6.385	3.534	3.142	2.851	3.243
Nov. 3 to Nov. 29	7.356	5.408	6.382	3.534	3.218	2.848	3.164
Nov. 30 to Dec. 26	6.854	4.787	5.820	3.248	2.801	2.572	3.019
Mean	6.975	5.160	6.067	3.329	2.871	2.738	3.196
1897.							
Dec. 27, 1896, to Jan. 22	6.895	5.038	5.966	3.349	2.900	2.617	3.066
Jan. 23 to Feb. 19	6.641	4.799	5.720	3.328	2.766	2.392	2.954
Feb. 20 to Mar. 18	6.728	5.102	5.912	3.426	2.706	2.486	3.206
Mar. 19 to Apr. 14	7.230	5.283	6.256	3.836	3.016	2.420	3.240
Apr. 15 to May 12	6.949	5.263	6.106	3.912	2.995	2.194	3.111
May 13 to June 8	7.029	5.182	6.106	3.960	3.107	2.146	2.999
June 9 to July 5	6.785	4.944	5.864	3.448	2.984	2.416	2.880
July 6 to Aug. 2	6.807	5.177	5.992	3.401	3.037	2.591	2.955
Aug. 3 to Aug. 29	6.753	5.138	5.946	3.260	2.974	2.686	2.972
Aug. 30 to Sept. 25	7.169	5.582	6.376	3.582	3.210	2.794	3.166
Sept. 26 to Oct. 23	7.278	5.726	6.500	3.714	3.422	2.786	3.078
Oct. 24 to Nov. 19	7.051	5.286	6.168	3.384	3.208	2.784	2.960
Nov. 20 to Dec. 16	7.040	5.139	6.090	3.290	3.094	2.800	2.996
Dec. 17 to Jan. 13, 1898	6.603	4.704	5.654	2.979	2.708	2.675	2.946
Mean	6.925	5.169	6.047	3.490	3.009	2.557	3.038
1898.							
Jan. 14 to Feb. 9	7.085	4.813	5.949	3.476	2.901	2.478	3.048
Feb. 10 to Mar. 8	6.693	4.938	5.816	3.645	2.952	2.171	2.864
Mar. 9 to Apr. 4	6.880	5.376	6.128	3.576	2.983	2.552	3.145
Apr. 5 to May 2	6.527	4.816	5.672	3.630	2.783	2.042	2.889
May 3 to May 29	6.768	4.822	5.795	3.734	2.941	2.061	2.854
May 30 to June 25	7.057	5.210	6.134	3.807	3.248	2.327	2.886
June 26 to July 23	7.189	5.416	6.302	3.772	3.231	2.530	3.071
July 24 to Aug. 19	7.234	5.492	6.363	3.615	3.255	2.748	3.108
Aug. 20 to Sept. 15	7.282	5.791	6.536	3.880	3.489	2.656	3.047
Sept. 16 to Oct. 13	7.595	6.133	6.864	4.030	3.782	2.834	3.082
Oct. 14 to Nov. 9	6.919	5.234	6.076	3.660	3.250	2.416	2.826
Nov. 10 to Dec. 6	7.113	5.130	6.122	3.590	3.199	2.532	2.923
Dec. 7 to Jan. 2, 1899	6.527	4.617	5.572	3.178	2.722	2.394	2.850
Mean	6.990	5.214	6.102	3.661	3.133	2.441	2.969
1899.							
Jan. 3 to Jan. 29	6.698	4.907	5.800	3.558	2.900	2.242	2.900
Jan. 30 to Feb. 26	6.546	4.802	5.674	3.650	2.905	2.024	2.769
Feb. 27 to Mar. 25	6.668	4.848	5.758	3.527	2.862	2.231	2.982
Mar. 26 to Apr. 22	6.868	5.093	5.980	3.738	2.863	2.242	3.117
Apr. 23 to May 19	6.939	5.324	6.132	3.862	3.094	2.270	3.038
May 20 to June 15	7.089	5.369	6.229	3.789	3.145	2.440	3.084
June 16 to July 13	7.058	5.291	6.108	3.751	3.288	2.352	2.815
July 14 to Aug. 9	6.795	5.183	5.989	3.483	3.135	2.506	2.854
Aug. 10 to Sept. 5	6.994	5.523	6.258	3.690	3.418	2.568	2.840
Sept. 6 to Oct. 2	7.054	5.696	6.375	3.720	3.474	2.655	2.901
Oct. 3 to Oct. 30	7.118	5.722	6.420	3.678	3.416	2.742	3.004
Oct. 31 to Nov. 26	7.126	5.376	6.251	3.582	3.404	2.669	2.847
Nov. 27 to Dec. 23	6.913	5.066	5.990	3.366	3.139	2.624	2.851
Mean	6.912	5.246	6.074	3.646	3.156	2.428	2.919

TABLE No. 18.—*Results of discharge observations, Mississippi River.*

NEW MADRID, MO.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	New Madrid.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1899.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Oct. 18 a. m.	a2.80	.....	+0.04	53,244	58,510	25.2	27.5	32.0	2,115
Oct. 18 p. m.	2.82	.....	+0.06	53,583	58,806	25.3	27.6	31.5	2,115
Oct. 30 a. m.	2.65	.....	+0.03	53,528	59,114	25.3	27.7	33	2,117
Oct. 30 p. m.	2.66	.....	+0.04	54,064	59,629	25.5	28.0	32	2,117
Dec. 8 a. m.	5.28	.....	−0.12	58,926	58,926	27.7	27.7	34.5	2,131
Dec. 8 p. m.	5.25	.....	−0.09	58,926	.....	27.7	.....	.....	2,131

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1899.	*Sq. feet.*	*Feet.*	*Cu. feet.*				
Oct. 18 a. m.	.....	1.687	89,818	Meter.....	14	67	XI—Very light.
Oct. 18 p. m.	+296	1.693	90,706	.....do.....	14	46	Do.
Oct. 30 a. m.	+308	1.658	88,776	.....do.....	14	55	VI—Light.
Oct. 30 p. m.	+515	1.654	89,444	.....do.....	14	67	VI—Light to brisk.
Dec. 8 a. m.	−703	2.205	129,929	Rod floats ..	15	68	Calm.
Dec. 8 p. m.	.....	2.174	128,129	Meter.....	14	68	Do.

a New Madrid gauge, whose zero is 275.72 feet above Cairo datum.

New Madrid notes.—Haskell meter used. See Table No. 19 for ratings. Datum line taken at 5.28 feet on the New Madrid gauge as observed December 8, 1899.

ST. FRANCIS RIVER.

Date.	Gauges.			Cross section of discharge.					
				Area.		Depth.			
	Helena.	Local.	Rise or fall in preceding 24 hours.	Water.	Below datum.	Mean.	Mean datum.	Maximum.	Width.
1898.	*Feet.*	*Feet.*	*Feet.*	*Sq. feet.*	*Sq. feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Dec. 17.	a11.00	5.0	−0.10	2,745	.....	6.0	.....	10.4	458
Dec. 17.	.....	5.0	.....	2,704	.....	5.9	.....	10.1	458
Dec. 17.	.....	5.0	.....	2,710	.....	5.9	.....	10.0	458
Dec. 17.	.....	5.0	.....	2,690	.....	5.9	.....	10.1	458
Dec. 17.	.....	5.0	.....	2,693	.....	5.9	.....	9.9	458
Dec. 19.	10.50	5.11	−0.20	2,818	.....	6.1	.....	10.4	464
Dec. 19.	.....	5.12	.....	2,776	.....	6.0	.....	10.3	464
Dec. 19.	.....	5.13	.....	2,796	.....	6.0	.....	10.1	464
Dec. 19.	.....	5.15	.....	2,777	.....	6.0	.....	10.2	464
Dec. 19.	.....	5.16	.....	2,823	.....	6.1	.....	10.3	464

Date.	Scour or fill.	Mean velocity per second.	Discharge per second.	Method.	Number of velocity stations.	Number of soundings.	Direction and force of wind.
1898.	*Sq. feet.*	*Feet.*	*Cu. feet.*				
Dec. 17.	.....	2.20	6,039	Meter.....	9	35	Calm.
Dec. 17.	.....	2.31	6,233	.....do.....	9	19	Do.
Dec. 17.	.....	2.28	6,175	.....do.....	9	19	Do.
Dec. 17.	.....	2.27	6,093	.....do.....	9	19	Do.
Dec. 17.	.....	2.27	6,113	.....do.....	9	19	Do.
Dec. 19.	.....	b2.80	b7,888	Double floats	9	19	XI—Nearly calm.
Dec. 19.	.....	2.59	7,204	.....do.....	9	19	XI—Breeze.
Dec. 19.	.....	2.50	6,986	.....do.....	9	19	Do.
Dec. 19.	.....	2.62	7,279	Meter.....	9	19	Do.
Dec. 19.	.....	2.71	7,656	.....do.....	9	19	Do.

a Helena gauge, whose zero is 161.98 feet above Cairo datum.

b The deduced velocities at stations 4 and 6 are abnormally high; the discharge is regarded as doubtful.

St. Francis River notes.—Discharge section located about 15½ miles above mouth of St. Francis River, at approximately the same place as the section of 1896.

In the float observations the surface float was run at mid-depth. Haskell meter wheel No. 6 run at $\frac{6}{10}$ depth. Rating of January 10, 1898, used. The equation is $y=1.1268 \times +0.4306$. Local gauge not connected with Cairo datum.

TABLE No. 19.—*Velocities by simultaneous observations with two meters.*

Measured in the Mississippi River near New Madrid, Mo., at the low-water discharge section, 1899; velocities in feet per second.]

Date and designation of meter (1899).	Station 1.	Station 2.	Station 3.	Station 4.	Station 5.	Station 6.	Station 7.
October 18, a. m.:							
Haskell No. 6	1.06	1.15	1.48	1.72	2.06	1.99	2.21
Price No. 34	1.17	1.18	1.73	1.81	2.02	2.19	2.30
October 18, p. m.:							
Haskell No. 6	0.97	1.23	1.41	1.76	1.97	2.06	2.18
Price No. 29	1.08	1.28	1.60	1.97	2.10	2.12	2.28
October 30, a. m.:							
Haskell No. 6	1.08	1.08	1.34	1.71	1.98	2.02	2.24
Price No. 34	1.16	1.20	1.35	1.72	1.99	2.02	2.26
October 30, p. m.:							
Haskell No. 6	1.05	1.10	1.32	1.70	1.96	2.02	2.21
Price No. 29	1.22	1.26	1.36	1.68	1.97	2.06	2.22
December 8:							
Haskell No. 6	1.17	1.56	1.90	2.34	2.48	2.61	2.64
Price No. 34	1.23	1.56	1.84	2.28	2.53	2.68	2.78

Date and designation of meter (1899).	Station 8.	Station 9.	Station 10.	Station 11.	Station 12.	Station 13.	Station 14.
October 18, a. m.:							
Haskell No. 6	1.96	1.82	1.82	1.70	1.62	1.26	0.90
Price No. 34	2.04	1.99	1.97	1.73	1.57	1.47	0.85
October 18, p. m.:							
Haskell No. 6	2.06	1.88	1.75	1.90	1.39	1.34	0.90
Price No. 29	2.04	1.95	1.77	1.90	1.58	1.49	0.98
October 30, a. m.:							
Haskell No. 6	2.13	1.85	1.76	1.76	1.35	1.26	0.64
Price No. 34	2.13	1.94	1.74	1.90	1.42	1.34	0.86
October 30, p. m.:							
Haskell No. 6	2.10	1.85	1.80	1.76	1.37	1.25	0.52
Price No. 29	2.14	1.90	1.82	1.73	1.50	1.37	0.79
December 8:							
Haskell No. 6	2.71	2.45	2.26	2.26	1.96	1.86	1.45
Price No. 34	2.73	2.54	2.31	2.42	2.04	1.93	1.62

Remarks.—Meters at same proportional depth and about 8 feet apart, suspended on either side of anchored skiff.

Results of final reduction of meter-rating observations.

[Made in still water in slough near New Madrid, Mo.]

Meter.	Date.	*a.*	*b.*	Number of observations.	Length of base.	Limits of observed velocity per second.
					Feet.	*Feet.*
Haskell, wheel No. 6	Mar. 10, 1900	1.1751	0.0769	48	100	1.0 to 6.0
Haskell, wheel No. 6	Mar. 12, 1900	1.1573	0.1052	48	100	0.7 to 6.0
Price No. 29	Mar. 10, 1900	4.2906	0.1473	40	100	0.8 to 4.6
Price No. 29	Mar. 12, 1900	4.3927	0.0648	45	100	0.6 to 4.9
Price No. 34	Oct. 3, 1899	3.9765	0.0752	21	200	0.7 to 5.6
Price No. 34	Oct. 6, 1899	3.5424	0.1919	22	200	0.8 to 4.3
Price No. 34	Mar. 12, 1900	4.4460	0.0487	39	100	0.7 to 4.0
Price No. 34	....do	4.4757	0.0227	43	100	0.6 to 1.1

Remarks.—The arithmetical mean of the two ratings made with each meter in March, 1900, have been used in deducing the velocities of October and December, except that for Price meter No. 34 the mean of the October ratings were used for velocities of October 18, 1899.

APPENDIX 2 G.

REPORT OF MR. C. W. STURTEVANT, ASSISTANT ENGINEER, ON CARE ARD REPAIR OF PLANT AND DREDGING OPERATIONS ON THE MISSISSIPPI RIVER, BETWEEN CAIRO, ILL., AND HEAD OF THE PASSES, LOUISIANA.

U. S. DREDGE FLEET,
Memphis, Tenn., March 31, 1900.

CAPTAIN: I have the honor to submit the following report of operations of the United States dredge fleet, engaged in deepening the channels of the Mississippi River from the Head of the Passes to the mouth of the Ohio River, during the period commencing May 16, 1899, and ending March 31, 1900.

The operations of the year include the care and repairs to plant and the work of deepening the channel of the Mississippi River by dredging.

During the high-water stage, when not engaged in field work, the plant is assembled in one fleet for its care and repair. The force necessary to do this work is retained.

At the beginning of the low-water season the fleet is divided into separate dredging plants (each in charge of a master), consisting of one dredge, with pile sinker, steam tender, plunder barge, and rowboats.

Survey parties, each in charge of a surveyor, are also organized to make surveys and maps of the shoal crossings over which dredging may be necessary. The different dredging and survey parties are under the direction of the superintendent of dredging operations, who is provided with a suitable boat for making frequent trips over the field covered by operations, so that he may inspect the operations of the different parties and properly locate the work from personal examination and from the maps made of the shoal crossings.

CARE OF PLANT.

On May 16, 1899, the following plant, pertaining to dredging operations, was tied up to the bank at West Memphis, Ark. (232 R.), about 1 mile below the railroad bridge across the Mississippi River at Memphis, Tenn.:

Dredges: *Alpha*, *Beta*, *Gamma*, *Delta*, *Epsilon*, and *Zeta*	6
Steamboats: *Minnetonka*, *Vidalia*, *Search*, *Patrol*, and *Vulcan*	5
Pile sinkers: Nos. 21, 61, 971, 981, 982, 983, and 984	7
Quarter boats: Store boat No. 13 and office boat *Illinois*	2
Barges: Nos. 153, 201, 205, 207, 208, 211, 214, 215, 219, and 228	10
Test barge	1
Small sunk-deck flat	1
Calking flat	1
Skiffs	53

The three new small survey steamers, *Mercury*, *Venus*, and *Mars* were received at the fleet on May 19, 1899.

The steamer *Mississippi* was returned to the fleet on July 21, 1899, after having been repaired at Keokuk, Iowa.

The steamer *Mississippi* left Luxora, Ark., where it was employed as a dredge tender, on October 20, 1899, for St. Louis, Mo., to prepare for a semiannual trip of the Mississippi River Commission. The boat returned to the fleet on December 20, 1899, and again left for St. Louis on March 6, 1900; after making a round trip to New Orleans, La., with the Mississippi River Commission, returned to the fleet on March 27, 1900.

The new steamboats *Sachem* and *Choctaw* reported for duty in the field on October 12, 1899. The steamboats *Nokomis* and *Wynoka* arrived at the fleet on December 4, and the *Leota* on December 20, 1899.

The steamer *Vidalia* and the test barge, having been condemned, were sold at public auction on June 15, 1899.

The dredge *Gamma*, steamer *Choctaw*, pile sinker, and plunder barge left the fleet March 28, 1900, for work in Vicksburg Harbor, Mississippi, having been temporarily transferred to Maj. Thomas L. Casey, Corps of Engineers.

A telephone line has been erected from the fleet to and across the Memphis Railroad Bridge over the Mississippi River, where connection was made with the local telephone company's wires in Memphis, and a telephone has been placed in the office on the fleet.

REPAIRS TO PLANT.

Dredge Alpha.—Only such repairs were made to this dredge as were necessary to keep it afloat. The boat was used during the year as a machine shop and quarters for the fleet crew, and was not placed in commission during the low-water season. This dredge can not work at a greater depth than 12½ feet. The hull was built in 1893 and has never been repaired below the water line. The hull must be repaired and calked during the coming year.

Dredge Beta.—In May, 1899, the construction of the main cabin was under way. The outside of the cabin had been painted. Construction of cabin, the scraping and painting of the inside of the air chambers of the floating pipes, and repairs to machinery were continued, and finished in the early part of July, after which the boat was tested at the head of Presidents Island (232), opposite the fleet at West Memphis. After completion of the season's work general repairs to machinery were commenced.

inside of the casing of each pump has been bored out. One of the two lines of ...g pipe has been hauled out on the bank, repaired, sand blasted, and painted. ... work of increasing the buoyancy of the floating pipe, by the addition of the pon... of the dredge *Delta*, has been commenced. Patterns for new steel liners for the ... of the runners of the pump have been made. The compartments in the hull ...eing cleaned and oiled.

...dge Gamma.—Previous to the dredging season new cast-iron liners were placed ... main pump. A separator was placed in the main steam pipe. The floating ... were hauled out on the bank, sand blasted, and painted. General repairs to ...aces and machinery were made and the roof was painted.

While the dredge was at work at Fleeces Crossing, in the middle of the low-water ...n, the valve seat of the high-pressure cylinder was found to be badly worn, ...ably due to the removal of water from the steam by the separator mentioned ..., and improper lubrication under the new conditions. The cylinder was taken ... machine shop in Memphis, Tenn., where the valve seat was planed down and a ... valve put in place. At the end of the dredging season it was found necessary to ...n plane off the valve seat, and a new seat made of bronze plate, about nine-...enths inch in thickness, held in place by studs, has been made. It was noted ... the upper edge of the valve seat wore more rapidly than the lower edge. This ... attributed to the entry of live steam upon the edge of the valve. A baffle plate, to ...tribute the flow of the steam around the valve, was placed in the valve chest. The ...h-pressure eccentric yoke has been babbitted. The cast-iron liners, which were ...ly worn by last season's dredging, have been replaced by new ones, and the diam... of the lining has been extended by a 5-inch ring of wrought iron on each side. ...w cast-iron furnace door liners to the boilers have been put in place and the fur...s rebuilt. The roof, the floor of the cabin, and the boiler-deck guards have just ...n painted. The compartments of the hull have been cleaned and oiled.

Dredge Delta.—At the beginning of this period extensive alterations to the cabin ...re nearly completed. This work was finished and the entire boat painted. The ...tter shaft was found to be bent. It was taken ashore, heated, and straightened. ...e suction-ladder frame was strengthened by additional straps and truss rods. The ...ter-shaft bearings were renewed. Owing to the delay in the delivery of steel ...tings this boat was compelled to go into the field for work with the old sprocket ...ain. During the dredging season a new steel sprocket chain was received, after ...ich very little delay occurred from breaking of chain. Since the dredging season ...nor repairs to machinery have been continued. The worn-out casing in the after ...art of the pump has been turned out, and the edges of the flukes of the pump run...r have been turned off. A new and slightly larger piston rod for the low-pressure ...ylinder has been made. While boring out the eye of the piston to fit the new rod ... large blowhole was found, which so weakened this part of the piston head that a ...w one has been ordered from the builders of the engine. The compartments in the ...ull are being cleaned and oiled.

Dredge Epsilon.—Previous to the dredging season the main-pump casing was bored ...ut and new throat connections to the suction elbows put in place. A set of circular ...el liners was bolted on the inside of the casing of the main pump. The inside of ...e air chambers of the floating pipes was scraped and painted. A set of strainers ...as placed in the suction of the main pump, consisting of inch rods of iron placed ...orizontally across the mouth of the suction pipe. The machinery in general was ...verhauled. Since the dredging season the weighing apparatus in the discharge pipe ...f the main pump has been replaced by a solid riveted pipe. A new whistle has been ...ade. The pump runner was found to be badly worn, and a new runner of the ...closed type will be made. A new set of liners is now being put in place on the ...inside of the casing of the pump. The compartments in the hull are also being cleaned ...and oiled.

Dredge Zeta.—Previous to the dredging season the machinery was overhauled. The ...main pump was bored out and a new throat piece made for connecting the pump cas...ing to the suction elbows. A set of steel liners was placed on the inside of the casing ...of the pump. Strainer rods were placed in the suction head in the same manner as ...on the *Epsilon*. Since the completion of work in the field the cabin over the boilers ...has been shored up and the wooden stanchions at the after end of the boilers replaced ...by iron pipe. The weighing apparatus in the discharge pipe to the main pump has ...been replaced by a solid riveted pipe. The pump runner has been removed from the ...shaft, as it was found to be badly worn, and a new one will be cast. A new set of ...liners for the inside of the casing of the pump is now being put in place. The fly ...wheels have been removed preparatory to replacing the eccentrics, which were ...cracked during field operations. The compartments in the hull have been cleaned ...and oiled.

Steamer Mississippi.—During the dredging season, while towing the dredge *Epsilon* and its outfit up the river, the crank pin on the starboard side broke off. The piston head and cross head went forward and broke both cylinder heads. Repairs were made at a machine shop in Memphis, Tenn. After the dredging season was over the boat was laid up with the fleet at West Memphis, Ark., and the following repairs have been made: Wheel thoroughly overhauled; main deck repaired; new nosing all around; three new fenders; the outside of the boiler deck, main deck, and outside of hull have been painted; additional drains placed in the heating apparatus, and new canvas has been laid on the roof of the pilot house, texas, hurricane-roof skylight, and hurricane roof.

Steamer Minnetonka.—Minor repairs were made to the wheel and the port guard previous to the dredging season. Repairs have just been commenced to the starboard guard, and the wheel is being rebuilt.

Steamer Search.—This boat was hauled out on the bank in May, 1899. The hull was thoroughly overhauled and calked, and was painted above the water line. New cylinder timbers and new rudders were built. A large number of the timbers in the frame of the boat were replaced by new ones. The boat was launched July 22, 1899. The furnaces were repaired and the roof painted. Since the close of field operations a new wheel has been built and the furnaces again repaired. New plungers for the doctor have been made, and the cabin is now being painted.

Steamer Patrol.—New pitmans were made for this boat and the deck and guards calked. Minor repairs were also made to the wheel and new dunnage laid in the forward coal bunker.

Steamer Vulcan.—This boat was hauled out on the bank in December, 1899. The hull was sand blasted and painted and machinery overhauled. The shaft was found to be cracked in the port journal, and a new one has been received, ready to be put in place. One of the large feed pumps from the dredge *Alpha* and the dynamo and drop light of the steamer *Search* were placed on board while being used as a fleet tender during the high-water season.

Steamer Venus.—Minor repairs were made to the machinery and wheel. The hull was cleaned and oiled with raw linseed oil.

Steamer Mars.—Minor repairs have been made to this boat while in service. The hull has been thoroughly cleaned and oiled with raw linseed oil. The boiler is being turned around and placed farther aft, so as to admit of the construction of a sleeping and drafting room forward, which will better adapt the boat for survey work.

Steamer Mercury.—New stocks of extra heavy 4-inch pipe were made for the rudders of this boat. A burst feed pump was repaired.

Pile sinkers.—The hulls and machinery have received minor repairs.

New steamers.—*Sachem*, *Choctaw*, *Wynoka*, *Nokomis*, and *Leota*. Minor repairs to wheels and pipe fittings have been made. The steam steering apparatus has been installed on the *Leota*.

Quarterboat No. 13.—This boat was allowed to go aground during the high stage of river in April, 1899. The hull was thoroughly repaired and calked and the boat launched, after which it was fitted up with shelves and a freight elevator, to be used as a store boat.

Quarterboat Illinois.—Minor repairs have been made to the roof.

Skiffs.—The small boats of the fleet were overhauled and painted just previous to the commencement of the dredging season.

Sand-blast apparatus.—This plant has been transferred from pile sinker No. 983 to the steamer *Venus*. The steam valve and valve seat of the air compressor have been planed off. The steam cylinder has been bored out and a new set of packing rings made for the steam piston.

DREDGING OPERATIONS.

The work done by the dredge fleet during the low-water season of 1899 consisted of maintaining a navigable channel 9 feet in depth in the Mississippi River from the Head of the Passes to the mouth of the Ohio River at Cairo, Ill. This portion of the river was divided into three districts. The upper district extended from Cairo, Ill., down to and including Miss Hickmans Crossing (131). The middle district extended from Miss Hickmans Crossing down to and including the chute of Island 40 (213). The lower district extended from Island 40 downstream as far as any work was found necessary. Each of these districts was constantly patrolled by the survey parties on small steamers, and surveys were made of all bars where dredging was required or it was thought likely that dredging might be required.

The survey party in the upper district was quartered on the steamer *Patrol* until the latter part of the season, when it was replaced by the steamer *Mars*. The survey

ry in the middle district was quartered on the steamer *Vulcan*, and that in the er district on the steamer *Venus*. The steamer *Search* was used as an inspection for the superintendent of dredging operations. A constant patrol of the river inspection of the work of the dredges was made with this boat. No work was ed necessary below Cypress Bend (426).

In the latter part of October pilots reported shoal water at Illawara (564), Paw 588), Fords (710), and Red River (764) crossings. An examination and sur- at each place showed depths of at least 9 feet. The pilots did not know just re the deepest water was located. These channels were buoyed, and no further ble occurred on the lower river.

After the close of the dredging season, when the river had commenced to rise, a ey party was organized on board the steamer *Search* and a survey of all dredged nnels made. Tracings of all surveys made during the dredging season by the erent parties have been transmitted to your office. Frequent reports of the ths of the crossings and the pilots' marks for running the crossings were made to pilots' associations and local steamboats. Dredged channels and other narrow es in the river were buoyed with black and red keg buoys, black buoys being ed on the right-hand side of the channel and red ones on the left-hand side.

nly five dredges were put in commission for the season's work, the *Alpha* being at the fleet, to be placed in commission only in case of emergency. As the five dges in the field were very successful in keeping open for navigation all shoal ssings, the *Alpha* remained at the fleet during the entire season. All the plant ployed during the season was the property of the United States with the excep- n of the steamer *Fred Hartweg*, which was chartered from August 8 to November 1899, at $40 per day, making the total charter money $4,200. Owing to a lack towboats during the early part of the season, the dredges were not accompanied the same steamers, the tenders being constantly changed from one dredge to nother.

DESCRIPTION OF WORK BY DREDGES.

Dredge Beta.—As this dredge can excavate to a greater depth (20 feet) than any of e other dredges, it was placed in commission to commence work when there was ll considerable depth in the channels. Examination indicated that the first shoal uld occur at Fleeces Crossing (243).

The dredge *Beta* and accompanying plant, in tow of the steamer *Mississippi*, left e dredge fleet at West Memphis, Ark. (232), at 10 a. m. August 2, 1899, and rived at Fleeces Crossing at 12.30 p. m. the same day and commenced dredging at 30 p. m. Various delays occurred in the work at this place, owing to the extreme t weather and the sickness of the crew. It was only possible at times to get borers and firemen enough to run one of the main pumps. On August 11 one of e piston rods on the starboard engine became heated, and the rod and glands were badly scratched that they were taken to Memphis, Tenn., the rod turned off and e glands rebushed. The accident did not delay the work, as it was impossible, th before and after the accident, to hire sufficient men to handle the fuel.

On August 24 work on this bar by the dredge *Beta* was stopped, as the upper end f the channel had been sufficiently deepened, and there was not room enough at he lower end of the channel for two dredges to work advantageously, the *Gamma* aving been placed at this bar to assist the *Beta*. The *Beta* was tied up to the bank o await a lower stage of river and clean boilers, after which the dredge was moved o Presidents Island and was anchored in position in this crossing on August 28. Dredging was commenced at 2 p. m. the same day. Considerable delay was occa- ioned by the necessary removal of large quantities of drift, coal, and lignite from the uction heads and the pulling down of head piles, owing to the great strain neces- ary to be put on the head cables on account of the swift current and compact mate- ial of which the bar is composed. The dredging necessary at Presidents Island was finished at 8 a. m. September 3, and the entire outfit, in tow of the steamer *Minne- onka*, left at 1 p. m. that day for Cherokee Crossing (90). The movement of the tow was necessarily slow on account of the swift current and trouble experienced in mounting the reefs with so large a tow, it being necessary to double-trip three of the crossings. In mounting the reef at Miss Hickmans Crossing (131) the spud was dropped to keep the dredge from swinging into shoal water and to straighten up the tow in the direction of the current. The spud was fractured at a point 7 feet from the lower end, and was afterwards cut off at this place.

The tow finally arrived at Cherokee Crossing on September 9, and actual dredging commenced at 1.10 p. m. the next day, assisting the dredge *Epsilon*, which had already commenced work.

At 2.30 a. m. September 13 the port line of discharge pipe became overloaded with sand, sunk, and capsized. The dredge was shut down and moved out to the

side of the channel while the pontons were being raised and turned over. These repairs were finished on September 16, and dredging again commenced at 7.45 a. m. the same day. The work necessary was finished at 10 a. m. September 18, and the dredge was tied up to the bank at Atkinson's field, near Cherokee Crossing, to await a lower stage of water. While tied up to the bank the plates on the blades of the pump runner were set out, so as to decrease the clearance between the blades and the pump casing. About the 10th of October shoal water commenced to develop at Point Pleasant (79), in the vicinity of the experimental dikes. The dredge *Beta* left Cherokee Crossing on October 12 and commenced dredging at 2.30 p. m. the same day on the Point Pleasant shoal. Work made good progress at this bar, with the exception of additional time required in dropping back to commence the cuts. Owing to a cross current setting around under the point of a reef at the upper end of the cuts, the dredge would float aground and have to be pulled into the channel by side lines or the steam tender. Dredging was stopped at 4.30 p. m. October 16, as there was a 9-foot channel throughout the entire length of the dredged cuts. The constant encroachment of the reef into the dredged channel caused the position of the main cuts to be made each time lower down on the bar. It was finally found necessary to dredge over the extreme west end of the 1898 dike, portions of which were removed by the use of a pile sinker dragging an anchor through the dike. On November 18 it was found necessary to shut the *Beta* down on account of the failure of the contractor to deliver Pittsburg coal, this kind of fuel being necessary for this dredge. As the dredge *Epsilon* had finished the work at Cherokee Crossing and could burn a cheaper kind of coal, which was obtainable, it was moved from Cherokee Crossing to Point Pleasant, and on November 10 the *Beta* left for West Memphis, Ark., to go into winter quarters with the fleet at that place. It arrived there on November 13, 1899.

Dredge Gamma.—This dredge was placed in commission, and on August 12, 1899. left the fleet at West Memphis, Ark., and arrived at Fleeces Crossing at 4.40 p. m. the same day, and commenced dredging at 10 p. m., assisting the dredge *Beta* in the work at this place. Only 500 feet of discharge pipe were in use, owing to the lack of rubber joints. Work continued without serious delay until August 26, when the dredge was anchored at the side of the channel to clean boilers, make a few needed repairs, and to see what effect the swift current would have in widening and deepening the cuts after the removal of the dredges. Upon examination of the machinery it was found that the high pressure valve and valve seat were so badly scratched that it was necessary to order a new valve from the makers of the engine and take the cylinder to Memphis to have the valve seat planed down. The dredge was therefore moved to Memphis, Tenn. (230), while making the repairs. The repairs were finished and the engine tested on September 7, and the next day the dredge left Memphis and returned to Fleeces Crossing, and dredging was commenced at 5.30 p. m. on that day. The long and tortuous channel dredged by the *Beta* and *Gamma* had been obstructed by the grounding of a packet boat near its head, and a new middle channel was chosen for improvement at this time. Work continued until September 15, when a new channel 9 feet in depth had been made, and the plant was tied up to the bank at the upper end of the crossing to await a lower stage of river.

Pilots on packet boats at the lower portion of the river reported shoal water on four bars between Fleeces Crossing (243) and Red River Landing (765); therefore the dredge *Gamma* left Fleeces Crossing on October 24 and proceeded down the river until shoal water was encountered. Examination of the river below gave a depth of 9 feet over all bars. At Cypress Bend (426) the channel was 9 feet in depth, but somewhat crooked and narrow. Dredging at Cypress Bend was commenced at 1.40 p. m. on October 29 and continued until 5.15 a. m. November 4, when an excellent channel 9½ feet in depth had been dredged. The plant was then tied up to the bank to await a lower stage of river.

On November 7 the *Gamma* departed upstream, and at Beiths Crossing (366) a narrow channel 9 feet in depth was found along the right bank. A new channel was dredged down the left bank by the dredge *Gamma*, commencing at 8 p. m. on November 9 and finished at 3.20 a. m. November 14. A survey was then made and the new channel was found to be narrow at its extreme upper end. Dredging was again commenced by the *Gamma* at 11.30 a. m. November 15, and the work necessary was finished at 9.45 p. m. the next day.

As no other shoal water had developed in this part of the river, the *Gamma* left Beiths (366) for winter quarters and joined the fleet at West Memphis, Ark., November 20, 1899.

Dredge Delta.—This dredge was placed in commission and left the fleet at West Memphis, Ark. (232), on the afternoon of August 9, 1899, being towed by the steamers *Minnetonka* and *Mississippi*. The *Delta* arrived at Island 34, which was the only shoal that would apparently develop in the vicinity selected for this dredge to work, at 11.15 a. m. August 11. Dredging was not commenced until 3.10 p. m.

gust 12, owing to trouble with jet pump on pile sinker and blowing out of steam kets on the dredge. Dredging continued with various delays, due to the bursting rubber joints on the discharge pipe and the slipping ahead of the discharge pipes the pontons, as well as the breaking and slipping of links of the sprocket chain of cutter machinery. On August 15 several links of the sprocket chain were lost in river, and it was not possible to continue work until repairs were made. The dge was therefore tied up to the bank until August 20, when dredging was again mmenced at 4.45 p. m. The old steel links continued to delay the work by becom- g unhooked while in operation, and on August 25 so many links were lost that it necessary to stop work until new links could be made. Each of the new links constructed of a 1½-inch pin and two car-coupling links.

Work was resumed at 12.15 a. m. August 31, and continued without serious delay til September 7, when the work necessary at this place was finished, and the boat tied up to the bank to await developments in the channel. During this period nsive repairs were made to the cutter machinery.

A survey of the upper end of the channel showed that a large ridge had formed arly across the channel, above where any previous dredging had been necessary, d at 4.10 p. m. September 11 the dredge was again placed in position to remove is ridge. A channel was dredged through this lump by 3 p. m. September 13, and e plant left Island 34 the next morning for Graves Bayou (250), where shoal water, feet in depth, had commenced to develop. The *Delta* arrived at Graves Bayou on ptember 15. Upon examination it was found that a new middle channel had devel- ed, with a depth of 10 feet, and the swift current was rapidly increasing both its idth and depth. No work being necessary, the dredge was tied up to the bank to wait a lower stage of river.

On September 17 the *Delta* was moved to Memphis, Tenn. (230), for convenience making some repairs to the cutter machinery.

Shoal water commenced to develop at the upper end of the channel at Island 34 179) about the middle of October, and the dredge *Delta* left Memphis on October and arrived at Island 34 on October 21, and commenced dredging at 3.45 a. m. tober 22. The work necessary at this bar was finished on October 25, after the sual delays in repairs to the cutter machinery. The plant was tied up to the bank await a lower stage of river.

As no other shoals developed in this portion of the river, the *Delta* left Island 34 November 16, and was tied up in winter quarters with the fleet at West Memphis, Ark., on November 17, 1899.

Dredge Epsilon.—This dredge was placed in commission and left West Memphis, Ark., on August 15, 1899, in tow of the steamer *Mississippi*, for Miss Hickmans Crossing (131).

On August 16, while in the chute of Island 40 (213), the steamer *Mississippi* broke its starboard wrist pin and the tow was anchored by means of the spud, the *Mississippi* returning to Memphis for repairs, using one engine. The steamer *Minnetonka* was sent to the *Epsilon* at Island 40, and left with the dredge in tow at 4.15 p. m. August 17, and arrived at Miss Hickmans Crossing August 19. It was necessary to send the towboat to New Madrid, Mo. (70), for a barge of coal, and dredging was not commenced until 8.30 p. m. August 21. Dredging continued without serious delay until the completion of the work at 10 a. m. September 1.

The *Epsilon* was moved to Cherokee Crossing (90) by the steamer *Mississippi* in two tows, the last tow arriving at Cherokee at 11 a. m. September 4. Only one head pile was sunk that day, owing to the breaking down of the jet pump on the pile sinker. Repairs were finished and dredging commenced at 12.30 a. m. September 5, and continued without serious delay. During the work at this bar it was found that the edges of the blades of the pump runner were so worn that over three-fourths of an inch clearance existed between the blades and the pump casing. Pieces of rubber joints were bolted on to the faces of the blades of the runner, of such size as to touch both sides of the casing of the pump. This change doubled the delivery head when running at the same number of revolutions as before, and very materially increased the output of the dredge.

The work necessary at this bar was finished at 5.30 a. m. September 22, and the boat was tied up to the bank to await a lower stage of river. On September 28 it was found that a shoal had developed in the central portion of the dredged channel at Cherokee Crossing, over which there was only a depth of 9 feet, and on the afternoon of September 28 the *Epsilon* commenced the removal of this shoal. Work continued until 1 p. m. October 6, when the shoal was removed and the dredge tied to the bank to await developments in the channel.

At 6 p. m. November 4 dredging was again commenced on a lump which had formed at the lower end of the channel. This work was finished at 11.15 a. m. November 6. The boat was then tied up to the bank to await a lower stage of river

On November 11 the *Epsilon* was moved to Point Pleasant, Mo. (79), to continue the work of the dredge *Beta*. Actual dredging was commenced at 6 p. m. on that day, and continued without serious delay until 6 a. m. November 17, when a good channel 9 feet in depth had been made.

As no further work seemed necessary, on November 26 the dredge left Point Pleasant for winter quarters at the fleet at West Memphis, Ark., arriving on November 28, 1899.

Dredge Zeta.—This dredge was the last one placed in commission. It left the fleet at West Memphis at 6.15 a. m., August 26, 1899, in tow of the steamer *Minnetonka*. The dredge arrived at Luxora, Ark. (163), where dredging was deemed necessary, at 5.25 p. m., August 27, and anchored the tow in the channel by means of the spud. The head piles were set and actual dredging commenced at 10 p. m. on that day. The sand on this bar is medium fine, with some gravel. The floating pipes were easily clogged, and on two occasions the pipes became so clogged with sand that the pump failed to have an opening for delivery, and on account of nondelivery lost its vacuum; and it was necessary to shut down the dredge, uncouple the pipes, reprime the pump, and wash out the sand from the suction and discharge pipes within the dredge.

The dredge was shut down from 10 p. m., August 30, to 2.30 p. m., August 31, on account of failure of contractor to deliver coal. The *Zeta* worked without the services of a tender, owing to the small number of towboats available, the survey boat *Vulcan* being in the vicinity to render temporary assistance. Work continued without serious delay until 4.30 p. m., September 7, when the plant was shut down to clean boilers, and the dredge was anchored out to one side of the channel.

At 11.55 p. m., September 8, the boilers having been cleaned, dredging was again commenced, and made good progress until 6.30 p. m., September 12, when the work necessary at this place was finished and the dredge was anchored to one side of the channel to await a lower stage of river. During this period rubber plates were placed on the blades of the runner of the pump on account of the clearance between the edges of the worn blades and the casing.

At 11.15 p. m., September 22, work was again commenced in the upper end of the dredged channel at Luxora and continued without serious delay until 8.50 a. m., September 25, when the towboat *Joy Patton*, with a raft of logs, floated down against the head piles and pile sinker. The raft broke the head line between the pile sinker and the head pile, which forced the pile sinker downstream. A line was, however, attached from the top of the leads to the pile, which pulled the leads, with three piles lashed thereon, overboard. The dredge was then tied up to the bank and the steamer *Mississippi* sent to Memphis to report the accident. The pile sinker of the dredge *Delta* was sent to Luxora, in tow of the steamer *Mississippi*, and the inspection steamer *Search*, with the carpenters of the dredges *Gamma* and *Delta* and such material as could be obtained, arrived at Luxora the next day. The broken leads and the three piles were taken out of the river by the assistance of the diving outfit, and temporary leads were constructed on the pile sinker.

Dredging was resumed in the channel at Luxora at 10.30 a. m., September 28. The work necessary to be done at this time was finished at 4.30 a. m., October 3, and the plant was anchored in the secondary channel, opposite Elmont Landing, so as to retard the flow of water and cause a deposit in this secondary channel and increase the flow of water through the dredged channel.

On October 10 the dredge was moved to the crossing known as Osceola Bar (164), to deepen the channel at that place. Actual dredging was commenced at noon on that day. At 11.45 a. m., October 12, the dredge was shut down, as the work necessary at this place was finished, and the *Zeta* was moved to Luxora, where a lump had commenced to form in the central portion of the dredged channel at that place. Actual dredging was commenced at 9.45 a. m., October 13. At 2.30 p. m., October 17, the plant was again anchored in the secondary channel at Luxora, as the work necessary to be done in the dredged channel had been finished.

On October 24 the dredge was moved to Fletchers Landing, at the lower end of Gold Dust Crossing (158). When enroute, and while the main engines of the *Zeta* were turned over to warm them up preparatory to the commencement of work, the port eccentric yoke broke. The eccentrics on both sides were found to be cracked, and they were strengthened with wrought-iron bands. The broken eccentric yoke was sent to Memphis and a new one cast. Repairs were finished and dredging commenced at the lower end of Gold Dust Crossing at 11.45 a. m., October 29, and continued with excellent success until 10 a m., November 2, when the work required was finished.

The *Zeta* was anchored in the secondary channel at Luxora, Ark., to await a lower stage of river. On November 4 it was found that the channel at Luxora (162) had narrowed near its central portion, and dredging was commenced at 2.30 p. m. on

a day. On November 8 the shoal had been removed and the plant was again anchored in the secondary channel. On November 26 the *Zeta* departed for winter quarters at West Memphis, Ark., arriving at that place the next day.

CONDITIONS OF CHANNELS AND RESULTS OF WORK.

Point Pleasant (*79*).—At this place the deepest part of the low-water channel was on the left shore, through the experimental dikes, along down close onto the head of what is called Phillips Towhead, which deflects the channel over to the right-hand shore at Lees Landing. The experimental dikes had been constructed in 1898 to deflect the current over to the right bank and save the caving on the head of Phillips Towhead, and also to prevent the possibility of the channel going to the left of the towhead.

During the low-water season of 1899 these dikes were extended and increased in number for the same purpose. As the river commenced to fall it became necessary for the steamboats to go very close to the ends of the dikes in order to keep in the channel. The construction of these dikes formed a secondary channel at the place desired, but the depth was not at all times sufficient for heavily loaded boats, although at all times there was sufficient water through the original channel. This channel was not, however, used by heavily loaded boats on account of its obstruction by the dikes. While there was still a navigable depth through the original channel, it was decided on the 12th of October to commence dredging in the secondary channel to assist the dikes in the change desired. There was no choice in the location of the cuts; it was simply necessary to deepen this secondary channel. The work was not located from a dredging point of view—that is, where a channel could be easiest made—but to assist the dikes in doing the work according to the plan under which they were constructed. The end of the lower 1899 dike was carried out to the deepest portion of the channel and opposite to a bluff reef coming in from the right-hand shore. As the river continued to fall this reef continued to work downstream, and it became necessary to continually cut off the end of this reef and at the same time move the position of the dredged cuts lower down on the bar.

The work at this place was made successful in its results only by the repeated reopening of the channel. Had the cuts been located from a dredging point of view in the original channel the current would likely have maintained the channel depth. At no time during the low-water season was there less than 9 feet across this bar, although at times the depth in the secondary channel was as small as 8½ for a day or two, until the shoal had again been removed by the dredge.

In February, 1900, the steamer *J. B. Williams* grounded a tow in this vicinity and lost several barges of coal.

Cherokee (*90*).—The work at this place consisted in cutting through the reef along the axis of the channel which was used by the steamers. While the dredges *Epsilon* and *Beta* were at work in the early part of September, there were a few days when there was only 7½ feet through the available steamboat channel, but during the latter part of September and the remainder of the low-water season there was not less than 9 feet. The result of the work was excellent and the cuts properly located.

Miss Hickmans (*131*).—At this bar there was only one channel. Work was commenced while there was considerable depth of water. The cuts were not made in the line of deepest water, but a little lower down on the reef at about the location where it was thought the natural thread of the channel would be at a lower stage. This location also made the channel easier for the steamboats to run. The upper pool was tapped at its extreme lower end, and therefore funneled all the water into the dredged channel. The result of this work was excellent and the channel continued to improve during the latter portion of the low-water season after completion of work. At no time was there less than 9 feet over the shoal at this place.

Gold Dust Crossing (*158*).—At this place there were two channels, both of which were used by the steamers. The right-hand channel left the upper pool from its side and entered the lower pool at its extreme upper end. The left-hand channel left the upper pool at the lower end and was chosen for improvement, as its location was such as to receive the greater portion of the discharge from the upper pool. The work was successful in opening a good channel, and at no time during the season was there less than 9 feet of water.

Luxora (*162*).—At this place there were three channels. The left-hand channel left the upper pool about three-fourths of a mile above its lower end and flowed squarely across the river to Kate Aubrey Towhead. The middle channel left the upper pool at its extreme lower end and turned to the left across the river at an angle of 45 degrees. The right-hand channel also left the upper pool at its lower end, but flowed down along the right-hand shore in direct alignment with the axis of the upper pool. The right-hand channel was chosen for improvement. The

distance to be dredged was greater than that in the middle channel, but on account of the alignment it was thought best to improve this channel.

In all dredged channels of considerable length the current is deflected from side to side and forms secondary bends and crossings within that channel. For this reason it was necessary to resume work a number of times during the season. It is possible that the middle channel could have been kept open with less work during the season, but it would have required more work to have first opened up a channel the water in the right and left hand channels being deeper than in the middle channel.

The result of the work was satisfactory, and a depth of 9 feet was maintained at all times.

Osceola Bar (*164*).—Two routes were used by steamers in going from the upper to the lower end of Osceola Bar, one crossing the river from the head of Osceola Bar over to the foot of Island 30 and down by Plum Point, and again crossing the river to the foot of Osceola Bar. The other channel, which was the one chosen for improvement, was down the right-hand shore nearly all the way, and it was thought that during extreme low water this right-hand channel was in a position to receive a greater portion of the discharge; the work was located accordingly. For about three days before dredging at this place there was only a depth of 9 feet over the bar; during the remainder of the season the depth exceeded 9 feet. The results of the dredging were excellent and the location of the dredged cuts was apparently properly chosen.

Island 34 (*179*).—At this shoal there were two channels. The upper pool widened out at its lower end into two points; the left-hand channel leaving the upper pool at the left-hand point and flowing down the left shore. It was narrow and of less depth than the right-hand channel, which left the upper pool from its right-hand point and turned squarely across the river to the right into the head of the lower pool.

The right-hand channel was chosen for improvement on account of its greater depth and width, even though it was not in direct alignment with the upper pool. The bar which causes the division of the two channels was composed of gravel and lignite, and it was thought would cause the necessary deflection without erosion. The upper ends of the dredged cuts were located at the extreme right-hand point of the upper pool, but the lower end of the dredged cuts did not cross the reef at its deepest point, but lower down, making a better alignment for the channel and conforming to what was thought would be the probable tendency of the current at a lower stage of river, the work at this place having been commenced early in the season. The work was successful and the cuts properly located. At no time was there less than 9 feet over the shoal.

Presidents Island (*233*).—At this locality there were three channels. The left-hand one followed the left shore, leaving the upper pool from its left-hand side. The middle channel left the upper pool at its extreme lower end and turned to the left at an angle of 45 degrees across the river to the left-hand shore. This was the channel used by steamers and was deeper than either of the other two. The right-hand channel left the upper pool at its extreme lower end and was in alignment with the upper pool, but the distance to be dredged was very long, and it was thought that it would require constant dredging to keep open a long tortuous channel of this kind, therefore the middle channel was chosen for improvement. The results of the work were excellent and its location seems to have been proper.

Fleeces Crossing (*243*).—At the beginning of the low-water season there were three channels at this place. The left-hand channel left the upper pool about three-fourths of a mile above its lower end and entered the lower pool at its extreme upper end. The depth of the water and the velocity of the current in this channel were less than in the other two, and after an examination it was not considered worthy of a survey.

The middle channel left the upper pool about 1,000 feet above its lower end and turned squarely across the river under a bold reef into the upper end of the lower pool. This channel was the one used by steamboats and was a little deeper than the right-hand channel, but its alignment was such that it would not receive a direct flow from the upper pool.

The right-hand channel, which was the one chosen for improvement, left the upper pool at its extreme lower point and was in continuation of its axis. While the distance to be dredged was great, it was thought, as the river fell, the natural tendencies would be in favor of this channel, even though at this time there was less depth of water than in the middle channel.

Work was commenced on the right-hand channel and continued until there was 9 feet throughout its entire length. Finally the current commenced to form bends and reefs within this channel and it became necessary to resume work. Just at this time a heavily loaded packet boat, the *City of St Louis*, went aground at the right-hand

side of the channel at the upper end of the dredged cuts and swung around into the dredged channel, where it remained for some time. This caused a deposit in the right-hand half of the dredged channel at its upper end. The boat was finally pulled off the bottom and swung around and went aground on the other side of the channel. This completely blocked the passage and shoaled the upper end of the channel to a depth of 5 feet. In the meantime the current had commenced to scour a new channel across the bar, midway between the right-hand channel and the one which has been called the middle channel, at a place where early in the season there were no indications whatever of a possible channel. The current here was very swift. This channel was chosen for improvement and work commenced by the *Gamma* at once. The result of the work at the second location was excellent, and at no time thereafter was there less than 9 feet.

At the time the right-hand channel shoaled to 5 feet there was still 7 feet in what was called the middle channel, therefore for about one week the available steamboat channel at this place was only 7 feet in depth. At all times thereafter there was not less than 9 feet.

It is evident that the selection of the right-hand channel was wrong. Still, it is doubtful if a channel could have been maintained through the original middle channel, except by continuous work throughout the season. It is very questionable, even at this date, where the best location for the work would have been at the beginning of the season, as the place where the channel was finally made showed no indications whatever of being suitable for improvement.

The action of the current when deflected by the reefs formed across the head of the first dredged channel seemed to indicate that over bars where there is more than one channel, if one of the channels could be obstructed at its upper end so as to cause a greater portion of the discharge to take place through the channel chosen for improvement, the work of the dredges would not only be assisted, but the channel in many instances maintained.

Beiths (*366*).—At this place there were two channels, the right-hand one leaving the upper pool from its side some distance above its lower end and flowing down along the right-hand shore. The left-hand channel left the upper pool at its extreme lower end, and was in continuation of the axis of the upper pool. Although the depth of the left-hand channel was slightly less than that of the right, it was chosen for improvement on account of its alignment and swifter current. The work was successful and the proper channel seems to have been chosen for improvement. At no time was there less than 9 feet over this shoal.

Cypress Bend (*426*).—At this place there was only one channel. It was 9 feet in depth, but narrow and crooked. The work consisted in straightening and widening the channel, and its depth was increased to 9½ feet. The location of the work and the results obtained were excellent.

MAPS AND TABLES.

The following-named maps and tables have been transmitted to your office during the season:

Maps of shoal crossings showing the condition of the channel and location of cuts where dredging was found necessary.

Tables showing the time engaged at different kinds of work and the conditions under which the work was performed by the dredges.

Table showing the least depth over all shoals between Cairo, Ill., and the Head of the Passes at different dates during the low-water season.

Table showing cost of care of the plant and the cost of repairs to the different pieces of plant, as well as the cost of field operations at the different bars.

Respectfully submitted.

C. W. STURTEVANT,
Assistant Engineer, Superintendent Dredging Operations.

Capt. MASON M. PATRICK,
Corps of Engineers, U. S. A.

TABLE No. 20.—*Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1899.*

Plant.	Dredge Beta, Aug. 2 to Nov. 18.	Dredge Gamma, Aug. 12 to Nov. 20.	Dredge Delta, Aug. 9 to Nov. 17.	Dredge Epsilon, Aug. 15 to Nov. 28.	Dredge Zeta, Aug. 26 to Nov. 27.
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Towing in the field and to and from winter quarters	305½	236	210½	278½	100½
Other classified time, dredging operations	2,190½	2,188	2,213½	2,265½	2,154½
Total	2,496	2,424	2,424	2,544	2,256
Total distance towed .....miles..	327	411	274	306	158

BETA.

Points of operation.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Passing boats.	Making up tow.	Towing.	Not working; waiting lower stage, etc.	Total.
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Fleeces Crossing (243)	9½	429½	75½	9½	.....	5½	2	.....	531½
Presidents Island (233)	12½	121½	6½	59	.....	11½	10½	*a* 24	245½
Cherokee Crossing (90)	10	99½	5	*b* 79½	.....	10½	163	561	928½
Point Pleasant (81)	5	64½	18½	6½	6	14	4½	110	229
Point Pleasant (second time)	3	36½	2½	.....	2½	4	½	169	218½
Point Pleasant (third time)	4	156½	31½	23½	1	4	1	*c* 47½	268½
Moving into winter quarters	.....	.....	.....	.....	.....	.....	74½	.....	74½
Total and average	44	908	139½	178	9½	49½	256½	911½	2,496

Points of operation.	Towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth of suction.	Average depth of cut.	Average steam pressure.	Average speed of main pump (revolutions per minute).
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*		
Fleeces Crossing (243)	12	61	58,808	137	18	5.9	160	122
Presidents Island (233)	11	7	4,914	40	18	5.3	161	124
Cherokee Crossing (90)	143	9	7,719	78	17	4.9	163	155
Point Pleasant (81)	9	8	5,406	84	13	4.0	157	130
Point Pleasant (second time)	.....	7	5,005	136	12	4.1	162	131
Point Pleasant (third time)	.....	28	16,062	103	12	4.7	159	130
Moving into winter quarters	152	.....	.....	.....	.....	.....	.....	.....
Total and average	327	120	97,914	108	15	5.3	160	127

a Waiting for tender.
b Righting overturned pipe line.
c Includes 9½ hours after arriving at fleet.

From September 19 to October 11 tied at bank 10 miles below Cherokee.

TABLE No. 20.—*Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1899*—Continued.

GAMMA.

Points of operation.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Passing boats.	Making up tow.	Towing.	Not working; waiting lower stage, etc.	Total.
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Fleeces Crossing (243)	4	264½	32½	a 73½	10¾	11½	2	.....	398
Fleeces Crossing (second time)	6¾	130½	12¾	b 256¾	5	10½	8½	924½	1,355
Cypress Bend (426)	3¾	56¾	3¾	3	.....	2	68½	c 249½	386¾
Beiths Bar (366)	5¾	123¾	10½	3½	.....	8½	36½	7½	195½
Moving into winter quarters	.....	.....	.....	.....	.....	.....	88¾	.....	88¾
Total and average	20½	575½	59½	336½	15¾	32½	203¾	1,181	2,424

Points of operation.	Towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth of suction.	Average depth of cut.	Average steam pressure.	Average speed of main pump (revolutions per minute).
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Lbs.*	
Fleeces Crossing (243)	10	24	23,761	90	15	2	140	155
Fleeces Crossing (second time)	22	14	11,950	92	12	2.7	141	156
Cypress Bend (426)	184	7	6,250	110	13	4.1	140	152
Beiths Bar (366)	61	21	16,600	134	12	2.8	141	152
Moving into winter quarters	134	.....	.....	.....	.....	.....	.....	.....
Total and average	411	66	58,561	102	13.4	2.6	140.5	154

a 23¾ hours, valve seat and valve high-pressure engine.
b Repairing valve and valve seat high-pressure engine at Memphis, from August 28 to September 7.
c Includes 60¾ hours before reaching Cypress Bend.

TABLE No. 20.—*Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1899*—Continued.

DELTA.

Points of operation.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Passing boats.	Making up tow.	Towing.	Not working: waiting lower stage, etc.	Total.
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Island No. 34 (180)	18½	40½	12½	129½	.....	9½	39	14½	264
Island No. 34 (second time)	12½	71½	12½	138	.....	4½	2½	.....	240½
Island No. 34 (third time)	14	101½	17½	205	.....	13½	8½	5½	360
Graves Bayou (250) and waiting lower stage river	.....	.....	.....	.....	.....	2	43½	795½	840½
Island No. 34 (fourth time)	9½	48½	11½	21½	.....	12½	57½	a 535½	696
Moving into winter quarters	.....	.....	.....	.....	.....	.....	23	.....	23
Total and average	54	261½	53½	493½	.....	42	168½	1,350½	2,424

Points of operation.	Towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth of suction.	Average depth of cut.	Average steam pressure.	Average speed of main pump (revolutions per minute).
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Lbs.*	
Island No. 34 (180)	51	5	4,025	99	15	2.9	152	130
Island No. 34 (second time)	.....	8	7,850	110	15	4.3	155	131
Island No. 34 (third time)	3	15	12,125	120	15	5.8	152	131
Graves Bayou (250) and waiting lower stage river	98	.....	.....	.....	.....	.....	.....	.....
Island No. 34 (fourth time)	59	10	9,100	188	14	5.7	158	132
Moving into winter quarters	63	.....	.....	.....	.....	.....	.....	.....
Total and average	274	38	33,100	127	14.7	5.1	154	131

a 10 hours after arriving at fleet. From October 26 to November 16 tied up at Fulton, Tenn. No dredging was done at Graves. From September 17 to October 18 tied up below Memphis bridge.

TABLE No. 20.—*Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1899*—Continued.

EPSILON.

Points of operation.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Passing boats.	Making up tow.	Towing.	Not working: waiting lower stage, etc.	Total.
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Hickman's Crossing (131)	4	178	54	21¼	.....	8	106¼	a 48	420
Cherokee Crossing	8	319½	89	60½	.....	8	67¼	145¼	647¼
Cherokee (second time)	7	155¼	16¼	3	11½	7	.....	691	891
Cherokee (third time)	4¼	33½	2	7¼	.....	8	.....	111¼	166¾
Point Pleasant (81)	3	108¼	20	3¼	.....	4¼	9	b 210	358¼
Moving into winter quarters	.....	.....	.....	.....	.....	.....	60	.....	60
Total and average	26¼	794¼	131¼	95¾	11¼	35¾	243	1,206	2,544

Points of operation.	Towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth of suction.	Average depth of cut.	Average steam pressure.	Average speed of main pump (revolutions per minute).
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Lbs.*	
Hickman's Crossing (131)	102	33	21,480	121	17	5.3	130	178
Cherokee Crossing (90)	41	29	22,115	69	15	5.0	134	178
Cherokee (second time)	.....	12	10,115	65	17	6.3	137	178
Cherokee (third time)	.....	3	2,000	60	17	5.0	135	178
Point Pleasant (81)	10	10	9,165	84	15	5.6	134	178
Moving into winter quarters	153	.....	.....	.....	.....	.....	.....	.....
Total and average	306	87	64,875	82	16	5.5	134	178

a Waiting delivery of coal by contractor. b 12 hours at fleet, November 28.

TABLE No. 20.—*Summary of dredging operations, Mississippi River below Cairo, during low-water season of 1899*—Continued.

ZETA.

Points of operation.	Placing plant.	Dredging.	Changing cuts.	Repairs.	Passing boats.	Making up tow.	Towing.	Not working; waiting lower stage, etc.	Total.
	Hrs.	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*	*Hrs.*
Luxora (161)	2½	294½	21½	46½	4½	4½	37	*a* 237	648
Luxora (second time)	6½	158½	20½	2½	½	2	1	*b* 249	440½
Osceola Bar (165)	2½	42	5½	.....	.....	2	1½	14½	67½
Luxora (third time)	1½	84½	13½	1½	½	4½	2½	156½	266
Gold Dust (158)	2½	79	6½	*c* 125½	.....	5	5½	41½	265½
Luxora (fourth time)	1½	61½	17	9	½	5½	5	*d* 442½	542½
Moving into winter quarters	.....	.....	.....	.....	.....	.....	26	.....	26
Total and average	16½	720½	84½	185½	6	23½	78	1,141½	2,256

Points of operation.	Towed.	Number of cuts.	Total length of cuts.	Average rate of advance per hour.	Average depth of suction.	Average depth of cut.	Average steam pressure.	Average speed of main pump (revolutions per minute).
	Miles.		*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Lbs.*	
Luxora (161)	71	24	15,050	51	15.	5.1	135	177
Luxora (second time)	.....	24	17,775	112	15.	4.8	140	174
Osceola Bar (165)	3	11	8,500	202	14.	4.4	139	173
Luxora (third time)	3½	13	12,400	146	14.	4.4	142	176
Gold Dust (158)	5½	10	8,950	113	14.	4.9	145	178
Luxora (fourth time)	4	15	12,800	207	14.	4.9	143	177
Moving into winter quarters	71	.....	.....	.....	.....	.....	.....	.....
Total and average	158	97	75,475	105	14.3	4.8	141	176

a Includes 15½ hours waiting for fuel.
b Includes 70 hours delay on account of accident to pile sinker.
c Includes 116 hours repairs to eccentrics main engines.
d Includes 14½ hours after arrival at fleet.

TABLE No. 21.—*Distribution of expenditures, dredging operations, during low-water season of 1899.*

DISTRIBUTION OF COST.

Plant.	Locality of work.	Labor.	Office supplies.	Subsistence.	Fuel.	Lighting supplies.
Dredge Beta	Fleeces Crossing	$2,813.60	$2.63	$714.96	$2,216.83	$12.07
	Presidents Island	1,299.64	1.21	330.24	1,068.90	5.58
	Cherokee Crossing	4,915.15	4.60	1,248.95	1,420.16	21.08
	Point Pleasant	1,212.44	1.13	308.08	528.44	5.20
	Point Pleasant (second time)	1,156.68	1.08	293.92	333.88	4.96
	Point Pleasant (third time)	1.420.02	1.32	360.83	1,347.61	6.09
	Moving into winter quarters	396.60	.37	100.52	326.40	1.70
	Total	13,213.13	12.34	3,357.49	7,242.22	56.68
Dredge Gamma	Fleeces Crossing	1,394.49	1.10	350.52	850.41	6.94
	Fleeces Crossing (second time)	4,724.37	3.75	1,193.39	421.94	23.61
	Cypress Bend	1,335.33	1.07	340.62	318.19	6.74
	Beiths Bar	684.57	.54	172.18	345.01	3.41
	Moving into winter quarters	312.71	.25	78.16	228.69	1.54
	Total	8,451.47	6.71	2,134.87	2,164.24	42.24
Dredge Delta	Island No. 34	1,087.85	1.35	310.31	298.69	12.20
	Island No. 34 (second time)	990.96	1.22	282.67	506.67	11.12
	Island No. 34 (third time)	1,483.49	1.83	423.17	700.42	16.64
	Graves Bayou, and waiting lower stage of water.	3,463.42	4.28	987.95	460.75	38.86
	Island No. 34 (fourth time)	2,868.00	3.55	818.10	339.87	32.18
	Moving into winter quarters	94.79	.12	27.04	128.40	1.06
	Total	9,988.51	12.35	2,849.24	2,434.80	112.06
Dredge Epsilon	Hickmans Crossing	1,675.41	3.34	464.06	1,435.90	12.41
	Cherokee Crossing	2,582.99	5.15	715.44	1,756.75	19.14
	Cherokee Crossing (second time)	3,554.30	7.08	984.47	765.73	26.34
	Cherokee Crossing (third time)	665.23	1.33	184.25	181.37	4.93
	Point Pleasant	1,431.14	2.85	396.40	720.52	10.61
	Moving into winter quarters	239.40	.47	66.31	217.21	1.77
	Total	10,148.47	20.22	2,810.93	5,077.48	75.20
Dredge Zeta	Luxora	2,957.36	2.91	816.96	1,542.32	36.77
	Luxora (second time)	1,995.45	1.97	555.06	847.74	24.98
	Osceola Bar	307.00	.30	85.42	337.19	3.84
	Luxora (third time)	1,199.04	1.19	335.37	450.25	15.10
	Gold Dust	1,195.50	1.19	334.74	712.00	15.07
	Luxora (fourth time)	2,455.94	2.43	683.96	323.14	30.79
	Moving into winter quarters	122.80	.12	32.76	167.31	1.47
	Total	10,233.09	10.11	2,844.27	4,379.95	128.02
Steamer Search	Inspection	4,610.35	14.93	1,351.87	961.80	12.37
Steamer Patrol	Surveys	2,182.86	1.87	871.71	506.62	5.46
Steamer Vulcan	do	2,458.99	7.06	425.56	352.99	2.18
Steamer Venus	do	2,429.16	9.25	379.46	390.08	8.23
Steamer Mars	do	1,396.50	.....	189.35	259.88	1.21
Steamer Search	do	320.00	.....	62.38	198.00	.....
	Grand total	65,432.53	94.84	17,277.12	23,968.06	443.65

TABLE No. 21.—*Distribution of expenditures, dredging operations, during low-water season of 1899*—Continued.

DISTRIBUTION OF COST—Continued.

Plant.	Locality of work.	Lubricants.	Miscellaneous repairs.	Hire of plant.	Total.
Dredge Beta	Fleeces Crossing	$67.15	$459.23		$6,276.46
	Presidents Island	26.40	212.12		2,944.09
	Cherokee Crossing	99.83	802.25		8,512.02
	Point Pleasant	24.63	197.89		2,277.81
	Point Pleasant (second time)	23.49	188.79		2,002.80
	Point Pleasant (third time)	28.84	231.77		3,396.48
	Moving into winter quarters	8.04	64.57		897.20
	Total	268.38	2,156.62		26,306.86
Dredge Gamma	Fleeces Crossing	25.85	256.86	$334.95	3,221.12
	Fleeces Crossing (second time)	88.00	874.50	1,140.36	8,469.92
	Cypress Bend	25.12	249.60	325.48	2,602.15
	Beths Bar	12.70	126.17	164.53	1,509.11
	Moving into winter quarters	5.76	57.27	74.68	759.06
	Total	157.43	1,564.40	2,040.00	16,561.36
Dredge Delta	Island No. 34	12.79	230.38	235.25	2,188.82
	Island No. 34 (second time)	13.55	209.86	214.29	2,230.34
	Island No. 34 (third time)	20.29	314.17	320.80	3,280.81
	Graves Bayou, and waiting lower stage of water.	47.36	733.46	748.96	6,485.04
	Island No. 34 (fourth time)	39.22	607.37	620.20	5,328.49
	Moving into winter quarters	1.30	20.07	20.50	293.28
	Total	134.51	2,115.31	2,160.00	19,806.78
Dredge Epsilon	Hickmans Crossing	24.09	203.66		3,818.87
	Cherokee Crossing	37.13	313.97		5,430.57
	Cherokee Crossing (second time)	51.09	432.04		5,821.05
	Cherokee Crossing (third time)	9.56	80.86		1,127.53
	Point Pleasant	20.57	173.96		2,756.05
	Moving into winter quarters	3.44	29.10		557.70
	Total	145.88	1,233.59		19,511.77
Dredge Zeta	Luxora	40.88	316.64		5,713.84
	Luxora (second time)	39.17	215.13		3,679.50
	Osceola Bar	6.03	33.10		772.88
	Luxora (third time)	23.57	129.99		2,154.51
	Gold Dust	23.72	129.74		2,411.96
	Luxora (fourth time)	48.27	265.09		3,809.62
	Moving into winter quarters	2.31	12.70		839.47
	Total	183.95	1,102.39		18,881.78
Steamer Search	Inspection	13.95	271.85		7,237.12
Steamer Patrol	Surveys	2.00	20.22		3,590.74
Steamer Vulcan	do	7.81	8.03		3,262.61
Steamer Venus	do	9.15	79.62		3,304.95
Steamer Mars	do	1.55	53.42		1,901.91
Steamer Search	do				580.38
	Grand total	926.61	8,605.45	4,200.00	120,946.26

TABLE No. 25. Depths over bars at crossings, low water, autumn of 1899.

Names of bars.	Distance below Cairo.	Aug. 12–20.	Aug. 22–23.	Sept. 5–9.	Sept. 10–16.	Sept. 17–23.	Sept. 24–30.	Oct. 1–10.	Oct. 11–21.	Oct. 22–31.	Nov. 1–10.	Nov. 11–20.	Nov. 21–23.	Dec. 10–13.
	Miles.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Cairo (gauge readings)	0	16 to 15	13.2 to 12.5	6.8 to 6	5.9 to 5.8	5.7 to 5.8	5.7 to 4.9	4.7 to 3.5	3.4 to 3.4	3.4 to 3.4	3.7 to 4.6	4.8 to 7.2	7.1 to 6.9	6.48 to 6.6
Medleys	30	.....	.....	.....	.....	10.5	10.5	.....	9.5	.....	9.0	.....	9.0	.....
Phillips	54	.....	.....	.....	.....	.....	.....	.....	9.0	.....	10.5	.....	.....	.....
Donaldsons Point	58	.....	.....	.....	.....	11.0	.....	.....	.....	.....	.....	.....	.....	.....
Kentucky Point	69	.....	.....	.....	.....	11.0	.....	.....	.....	.....	.....	.....	.....	.....
Morrisons	69	.....	.....	.....	.....	12.0	.....	.....	.....	.....	.....	.....	.....	.....
Watsons	74	.....	18.0	.....	10.5	9.5	.....	9.5	9.5	.....	9.0	.....	.....	12.0
Nolands	75	20.0	15.0	.....	10.5	11.0	.....	10.5	.....	.....	9.0	.....	.....	11.0
Point Pleasant	79	20.0	15.0	.....	12.0	11.5	.....	12.0	10.5	9.0	11.0	9.0	9.0	10.0
Lees Landing	81	.....	.....	.....	.....	.....	.....	.....	10.5	9.0	9.5	13.5	13.5	.....
Gurvins	82	19.5	.....	.....	12.0	12.0	.....	13.5	12.0	.....	13.5	12.0	15.0	12.0
Cherokee	90	17.5	12.0	8.0	7.5	8.0	9.0	9.5	9.0	9.0	9.5	10.0	.....	10.0
Joe Eckles	92	.....	.....	.....	12.0	13.5	.....	13.5	.....	.....	.....	13.0	.....	15.0
Mrs. Bass	95	.....	.....	.....	10.0	9.5	10.5	9.5	9.0	9.0	9.0	9.5	12.0	9.5
Reel Foot	99	.....	.....	.....	12.0	13.5	.....	10.5	15.5	.....	10.5	.....	12.0	12.0
Hathaways	104	21.0	16.5	.....	9.0	10.0	10.5	10.5	9.0	10.5	10.0	12.5	16.5	15.0
Gayoso	105	.....	.....	.....	12.0	10.5	.....	10.5	10.5	.....	10.0	12.0	.....	.....
Booths Point	118	.....	.....	.....	9.0	9.5	9.5	9.5	9.0	9.0	9.0	9.5	13.5	12.0
Tyler	127	.....	.....	9.0	11.0	10.5	.....	10.5	9.0	9.5	9.0	12.0	12.0	13.5
Miss Hickmans	131	14.0	12.0	9.0	9.5	12.0	12.0	10.5	10.0	10.5	12.0	13.5	13.0	15.0
Letterels	144	.....	.....	.....	.....	.....	.....	12.0	.....	.....	12.0	12.0	12.0	.....
O'Donnells	149	.....	.....	.....	.....	11.0	.....	10.0	9.5	9.0	9.0	11.0	12.0	12.0
Gold Dust	158	.....	.....	9.5	9.5	9.5	9.5	10.5	9.0	9.0	10.0	12.0	10.5	12.0
Kate Aubrey	162	.....	12.0	6.0	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Luxora	162	12.5	12.0	9.5	9.5	9.0	9.0	10.0	9.5	10.5	9.0	11.0	12.0	12.0
Island No. 30	162	15.5	12.0	10.5	9.5	9.5	9.5	.....	.....	.....	.....	.....	.....	.....
Plum Point	164	.....	12.0	12.0	12.0	.....	.....	.....	.....	.....	.....	.....	.....	.....
Hales	164	.....	.....	.....	.....	.....	.....	.....	10.0	9.5	10.0	11.0	13.0	15.0
Osceola Bar	164	.....	.....	.....	.....	.....	.....	9.0	10.0	10.5	9.5	10.5	12.0	13.5
Last Chance	164	.....	.....	.....	.....	.....	.....	.....	.....	9.0	9.0	10.0	13.5	12.0
Bullerton	166	.....	.....	.....	.....	12.0	.....	10.5	10.5	.....	9.5	13.5	15.0	13.5
Island No. 34	179	13.5	13.5	9.0	9.5	11.0	11.0	10.0	9.0	9.5	10.0	10.5	13.5	9.0
Island 34 to Hatchee River	180	.....	.....	.....	.....	.....	.....	10.5	10.5	9.5	9.5	12.0	15.0	13.5
Morgans Point	181	16.5	13.5	.....	13.5	.....	.....	11.0	12.0	10.5	11.0	12.0	15.0	15.0
Bend of Island No. 35	191	16.5	13.5	.....	10.5	11.5	.....	10.0	9.0	12.0	12.0	13.5	13.5	15.0
Pecan Point	196	.....	.....	.....	13.5	.....	.....	12.0	13.5	13.5	.....	.....	12.0	11.0
Island 40	213	16.5	16.5	.....	12.0	13.5	.....	11.5	11.5	12.0	.....	12.0	.....	12.0
Wreck of Arthur	217	.....	.....	.....	.....	.....	.....	11.0	.....	.....	.....	.....	.....	.....
Old Hen	225	.....	.....	.....	11.0	10.5	.....	9.0	10.0	10.5	.....	11.0	13.5	10.5
Memphis (gauge readings)	230	9.3 to 10.9	9.8 to 9.2	4.4 to 3.8	3.6 to 2.8	2.8 to 2.5	2.6 to 2.2	2.1 to 1.3	1.2 to 0.8	0.8 to 0.5	0.5 to 1.0	1.1 to 2.4	2.7 to 3.0	2.4 to 2.6
Presidents Island	233	12.0	.....	.....	9.0	9.5	9.5	9.5	9.0	10.0	9.5	10.0	.....	.....
Fleeces	243	10.5	10.5	7.0	9.5	10.5	9.5	9.5	9.0	10.0	12.0	.....	.....	.....
Graves Bayou	250	.....	13.5	9.0	10.0	10.5	10.5	10.0	11.0	11.0	.....	.....	.....	.....

Between October 22 and 28, 1899, soundings were made over all crossings between Cat Island and mouth of Red River; the least depth found anywhere was 9 feet.

APPENDIX 2 H.

REPORT OF MR. WM. GERIG, ASSISTANT ENGINEER, ON EXPERIMENTAL DIKE WORK.

POINT PLEASANT, Mo., *December 30, 1899.*

CAPTAIN: I have the honor to submit the following report of operations of experimental dikes party from the 26th of May to the 30th of December, 1899.

Obeying your instructions, I arrived at Memphis, Tenn., on the 26th of May, and immediately commenced preparing the plant for this work.

PLANT.

Barges.—Five barges, 120 feet long, 30 feet wide, and 5 feet deep, loaded with lumber, piling, brush, poles, wire strand, spikes, and bolts, were obtained from the United States Engineer Office, First and Second districts, Mississippi River Commission. Four of these barges were unloaded and equipped with ways on which the dikes were built and from which the dikes were launched to place in the river.

The ways were placed athwartship of the barge and were 28 feet long, of 4 by 8 inch oak, spaced 8 feet centers, and had a slope of 1 on 5. In order to get the ends of the ways as near the water as possible, one side of the barge and deck was lowered 3 feet, giving one-half of the deck a slope of 1 on 5 from the center of the barge. The remaining half of the deck was not changed. The ways were placed on the sloping deck and their ends were 14 inches from the water when the barge was unloaded. The other ends of the ways were about 30 inches above the deck.

All of the barges were calked and repaired above the water line, braced on the inside, and the decks were repaired. These repairs were completed on the 25th of July.

Five barges, for field work, were chartered at $2.50 per day each. Two of these were owned by the New St. Louis Sand Company, of St. Louis, Mo., and the other three by Messrs. John Bell & Sons, of Leavenworth, Ind., and were delivered at New Madrid, Mo., to the Government, on the 1st of August.

Pile drivers.—Two old pile drivers, Nos. 21 and 61, were obtained from the dredge fleet, the hulls were calked above the water line, the machinery overhauled and repaired. These were found to be unserviceable, as their machinery was not of sufficient power nor of proper design to handle them in the current at Point Pleasant, Mo., crossing. They were used, however, until the 6th of September, when pile driver No. 4, borrowed from Capt. Edward Burr, Corps of Engineers, St. Louis, Mo., was received.

Quarterboats.—Quarterboat No. 156 was obtained from the United States Engineer Office, Third district, Mississippi River Commission, and was received at Memphis on the 25th of July. Quarterboat No. 5, with a complete outfit for 120 men, was borrowed from Captain Burr and was received at the works on the 12th of October.

Towboats.—The towboat *T. H. Davis* was chartered at $33.33 per day. This boat is 145 feet long, 30 feet beam, and has four boilers 38 inches in diameter by 26 feet long, and engines 18 inches in diameter by 6 feet stroke. She also had a sufficint supply of lines, rachets, chains, etc., for the proper handling of a tow. It required a boat of this power to tend this outfit.

All of the alterations and repairs to plant were completed on the 1st of August, and the total cost was $4,096.29.

MATERIAL.

Stone was obtained by contract from Mr. Fred Hartweg at $1.98 per cubic yard delivered on barges at the works. It was quarried and loaded at Grand Tower, Ill., and was retained on contractor's barges until placed in the work.

Brush and poles were obtained by contract from Messrs. Hunter and Frey at $0.98 per cord for brush and $1.50 per cord for poles delivered on Government barges at the brush camp.

Lumber was obtained by contract from Mr. F. L. Peck at $10.50 per 1,000 feet B. M., delivered on Government barges at Hathaway, Tenn.

Wire strand was on hand, being left over from the previous year.

Wire, wire-rope clamps, spikes, nails, bolts, and piling were obtained by contract from various parties.

CONSTRUCTION OF DIKES.

On the 4th of August all of the material had been loaded on the barges; most of the outfit had been assembled. The tow, consisting of ten pieces, was made up and left Memphis on the 5th, arriving at Point Pleasant, Mo., at noon on the 8th. The fleet was placed and dike construction was begun at once.

The dikes were built as follows:

First. A triangular frame of gum or sycamore lumber was made as shown on the detail drawing transmitted herewith (plate 52), the height of the frames varying with the depth of the water, the tops of the frames being at mean low water.

Second. The frames were set up on the ways, spaced 6 feet 8 inches centers, and bolted together. One section when completed was 115 feet long.

Third. The floor was next built by placing seven rows of large poles on top of the bottom timbers of the frames. The poles in each row were wired together, so as to make one continuous pole, and were also wired to each frame. On top of these the ground poles were placed. Small loose brush was placed on top of and wired to the ground poles below the back frame, so as to form a mat. Heavy loose brush was placed under the rock pile to prevent the rock from falling through.

Fourth. The rock ballast was placed. The amount of rock required varied from 0.2 to 0.35 cubic yards per linear foot of dike, depending on the velocity of the current and the depth of water. The back side of the rock pile was covered with heavy brush, well wired to the structure to prevent the rock from moving.

Fifth. The screen brush, placed as close together as possible, was nailed to the structure, all openings being filled with smaller brush. Three rows of large stringer poles were placed next on top of the screen brush. The poles in each row were wired together and to each frame and extended throughout the whole length of the structure, strengthening it longitudinally. In order to facilitate the tying of the anchor cables, loops were made of ⅞-inch wire strand, well fastened to the structure while the barge was at the bank.

Sixth. The section being completed, the barge was towed to the proper location, where the anchor piling had been driven. The cables were fastened to the loops by means of square knots, and the structure was launched from the barge to place in the river.

The anchor piles were four in number for one section, placed on a line 30 feet above and parallel to the dike line, and had a penetration of at least 15 feet. These were broken off at a point not less than 8 feet below mean low water after the dike was completed.

The anchor cables were ⅞-inch wire strands, fastened to the pile about 5 feet above its point, and 32 cables were required to hold one section when the velocity of the current was high and the water deep. In shallow water and low velocity of current only 16 anchor cables were required.

The dike was made continuous by sinking the sections on a straight line, the shore end of one section joining or slightly overlapping the channel end of the preceding section.

POINT PLEASANT, MO. (79), CROSSING.

During the season of 1898 two dikes of similar construction, about 3,800 feet apart, were placed here, located as shown on the maps transmitted herewith (plates 6-10 A). During this year four additional dikes were placed here.

It was found difficult to drive the anchor piling on account of the high velocity of the current and the great depth of water. The velocity of the current was more than 6 feet per second, and the depth of water was from 22 to 30 feet. The velocity of the current increases as the river falls, which is shown by the high and low water slopes at this point. The high-water slope per mile from Point Pleasant (79 R) to Tiptonville, Tenn. (86 L), is 0.267 feet, and the low-water slope is 0.901 feet. The latter is greater than at any other point below Cairo, Ill. Upon the receipt of pile driver No. 4 no more delay was caused by the failure to drive piling.

Another great difficulty was found in launching the structure to its place in the river. Two sections broke in two, dumped their loads, broke the anchor cables, and floated away. The structure was then strengthened and built in accordance with the detail drawing herewith (plate 51), and no more broke, but several got away by breaking the anchor cables, although double the estimated number of cables were used.

In this depth of water and high velocity of current it was difficult to make close connections, and, therefore, the dikes had to be reinforced in a number of places by placing other sections below the openings to prevent erosion between the ends.

Some delay was also caused by the failure of contractors to deliver material

promptly. Several days were lost waiting for stone, and a force was employed for a period of two weeks cutting brush. Labor also was scarce and of an inferior quality.

At the end of each dike the bank was revetted by the placing of a fascine mat. The mats were each about 60 feet long by 40 feet wide and 9 inches thick, and extended from the top of the bank to the foot of the slope, or to deep water. The bank was graded to a slope of 1 on 3 before the mat was placed. The mat was entirely covered with a layer of stone about 8 inches thick, and the dike was continued up the slope and connected with the mat. At Point Pleasant 96 squares of bank work were placed.

Sixty-six hundred linear feet of dikes were built here, including 230 linear feet placed on the channel end of Dike No. 98–1, and also 460 linear feet built to repair Dike No. 99–4 which was damaged by steamboats running over it. About 600 linear feet were lost.

The work laid out at Point Pleasant was completed on the 31st of October and the outfit was moved to Cherokee Crossing.

SUMMARY OF RESULTS AT POINT PLEASANT CROSSING.

On the 8th of August, when the New Madrid gauge read 13 feet, the direction of the current was from a point about 300 feet above the Point Pleasant Light to the bar at the location of Dike No. 99–2, causing the bank to cave from there down to the foot of the bar. The volume of water then divided into two channels, one to the left and the other to the right of Dike No. 98–2. As the river fell the current continued further down the Missouri shore and struck the bar between Dikes 99–1 and 99–2. After these two dikes had been placed the bar stopped caving, and a large per cent of the discharge passed to the right of Dike No. 98–2 and struck the lower end of the Point Pleasant bar causing it to cave, but that portion of this bar opposite the dikes was not cut away because of an underlying stratum of gravel. Dikes Nos. 99–4 and 99–3 were placed, to still further reduce the discharge, to the left of Dike No. 98–2.

The following results were noted on the 1st of November:

First. The entire prevention of bank erosion of the bar.

Second. The discharge to the left of Dike No. 98–2 was reduced and the channel became very narrow and crooked.

Third. The discharge to the right of Dike No. 98–2 was increased, but since the location of the gravel reef was such as to cause a low velocity of current below it, all of the sand washed from the top of the bar over it was deposited there. This crowded the channel downstream and thence it spread out into several channels.

Fourth. The water was considerably deepened at the channel ends of the dikes.

Fifth. There was some fill below the dikes, but since the river fell continually and very slowly, the water was almost clear, and it carried a very small amount of material in suspension to be deposited.

CHEROKEE CROSSING (89).

The project here consisted of placing a dike, 1,500 feet long, to close the chute along the bank and the well-defined right-hand channel. A second dike, 600 feet long, was placed about 600 feet below to reenforce Dike No. 1, as shown on the map transmitted herewith (plates 16, 16A).

The plant was moved to this place on the 2d of November, and the first section was sunk on the 3d. The depth of water on the dike lines was from 5 to 9 feet, except in the chute, where the depth was from 18 to 25 feet. The velocity of the current was not high, the low-water slope from Tiptonville (86 L) to Stewarts, Mo. (90 R), being 0.54 foot per mile; and consequently it was not difficult to drive the piling or to launch the sections of the dikes and make good connections. Only one section failed to connect, and this was made good by placing a short section below the opening, so as to lap both of the upper sections.

The bottom of the deep chute consisted of mud, and the section placed there settled about 4 feet. This part of the dike was reenforced by placing below it another section built of higher frames.

Twenty-three hundred and twenty linear feet of dikes were placed here, including one section which left the barge prematurely and lodged below Dike No. 2. The bank at the ends of the dikes was protected in the same manner as at Point Pleasant, and 48 squares of bank work were placed.

The work here was completed on the 30th of November, when operations were suspended and the fleet taken to West Memphis, Ark., and laid up with the dredge fleet. Considerable delay was caused by the scarcity of labor, and five days were lost, three by wind and rain and two days by the failure of contractor to deliver stone.

SUMMARY OF RESULTS AT CHEROKEE CROSSING.

The results attained on the 1st of December were:

First. The discharge through the chute was greatly decreased, the velocity of the current being very low after the dikes were placed.

Second. The bar stopped caving.

Third. The velocity of the current increased, and the water deepened, at the channel ends of the dikes.

Fourth. There was some fill below both dikes, and the chute showed a tendency to narrowing.

SURVEYS.

A survey party consisting of an instrument man, a recorder, a leadsman, and three rodsmen was employed in connection with this work. Three surveys of the channel in the vicinity of the dikes were made per week, both at Point Pleasant and Cherokee crossings.

Transmitted herewith is a table (No. 23) showing the cost of field work in detail and the quantities of material required per unit. A total of 8,920 linear feet of dikes were built during this period, at a cost of $39,088.97. The cost per linear foot was $4.38. This cost is large, due to the advanced prices of material and to the cost of hire of plant. The hire of plant was about 16 per cent of the total cost of the work and the actual running expenses of the steamboat were 12 per cent more, making a total of 28 per cent for these two items. With this outfit double the amount of work could have been done at an increased labor cost of about 40 per cent had labor been plentiful.

The total number of days actually employed building dikes was ninety-two, the rate per working day being 97 linear feet. The average number of men employed per day was 91. The wages paid were $30 per month and subsistence for river men and carpenters' helpers, and $25 per month and subsistence for labor. Self-subsisting labor was paid $1.20 per day of eight hours.

In conclusion, I see no way of making improvements in the construction of these dikes except to increase the dimensions of the lumber for the high dikes. The wire strand used should be at least one-half inch in diameter and pliable. The slope of the ways should be decreased to 1 on 15, then the dike will leave the barge in almost its normal position, and the strains on the anchor cables will be better distributed. The danger of leaving the barge prematurely will be reduced to a minimum. The barge will have to be drawn from under the structure by a steamboat. The conditions at Point Pleasant were unquestionably the most unfavorable on the lower river for the placing of these dikes, and better results may be shown after there has been a decided rise in the river.

Respectfully submitted.

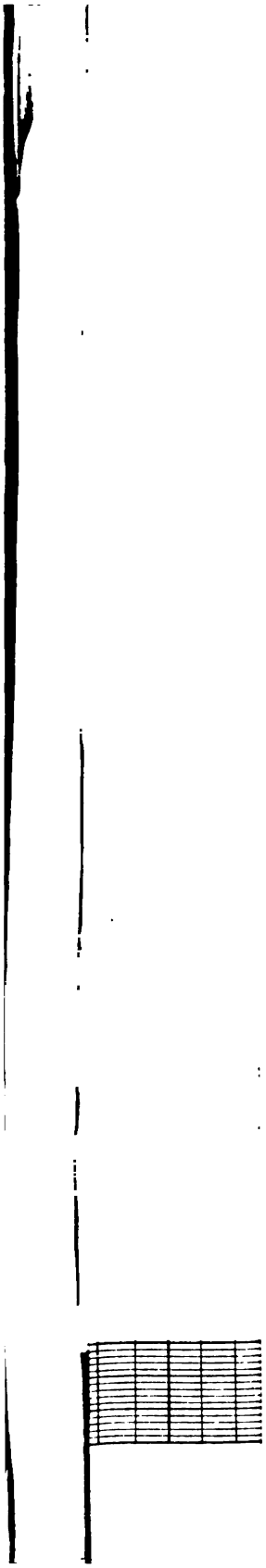
WM. GERIG, *Assistant Engineer.*

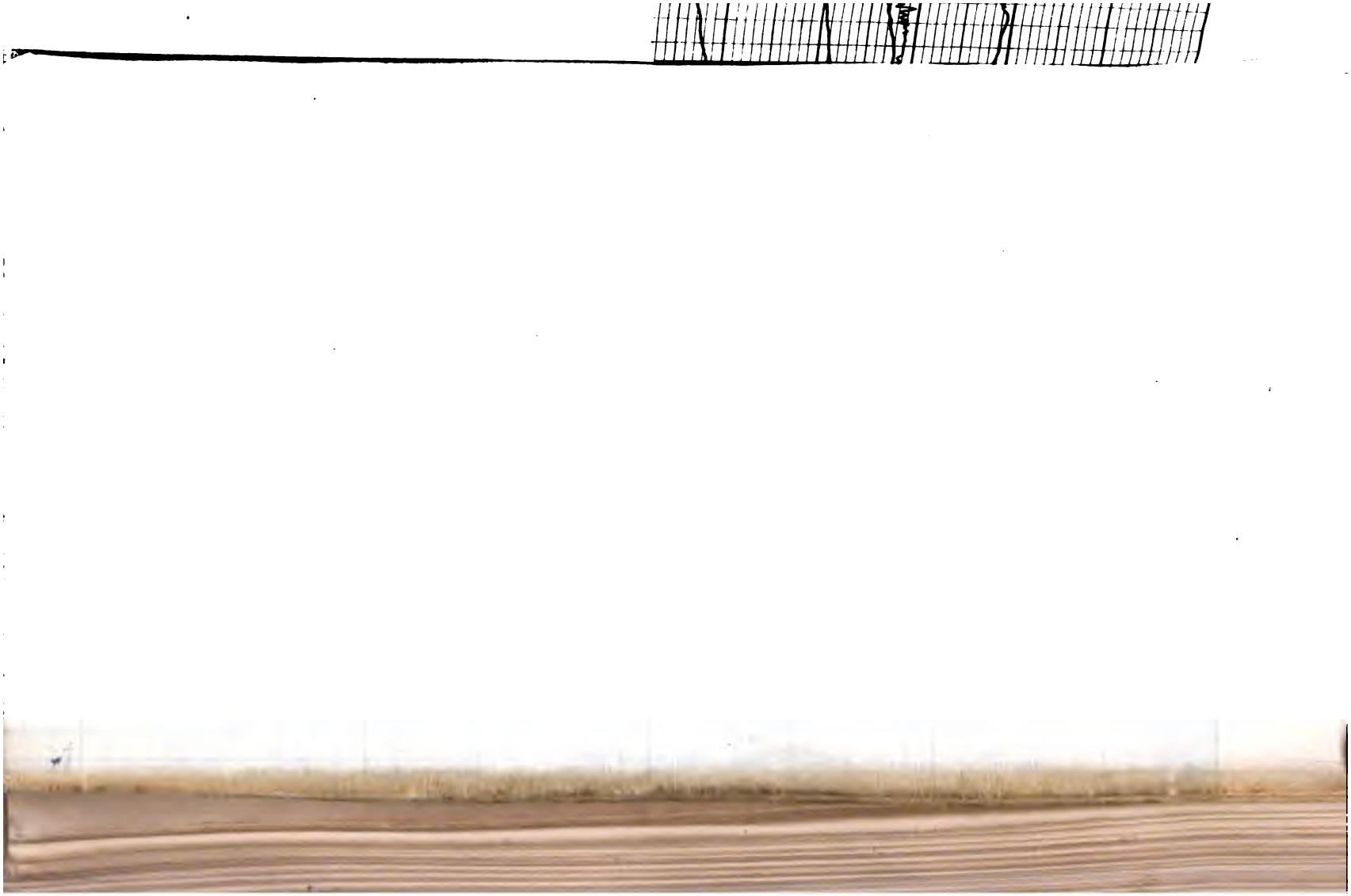
Capt. MASON M. PATRICK,
Corps of Engineers, U. S. A.

TABLE No. 23.—*Abstract of expenditures for experimental dike work at Point Pleasant and Cherokee crossings, 1899.*

Items.	Designation.	Construction dikes at Point Pleasant, Mo.		Construction dikes at Cherokee Crossing.		Bank work.		Totals.		Cost per 100 feet of dike.	
		Amount.	Cost.	Amount.	Cost.	Amount.	Cost.	Amount.	Cost.	Amount.	Cost.
Labor			$8,491.58		$3,700.44		$850.00		$13,042.02		$146.21
Subsistence			2,671.37		1,027.59		211.43		3,910.39		43.83
Hire of plant			4,122.73		2,061.32				6,184.05		69.33
Lumber	Feet B. M	186,500	1,810.75	65,131	689.12			251,631	2,499.87	2,820.9	28.03
Brush	Cords	1,420.04	1,406.86	563.2	551.93	25	24.50	2,008.24	1,983.29	22.51	22.23
Poles	do	393.8	590.70	114.5	171.75			508.3	762.45	5.69	8.55
Piling	Linear feet	8,512	680.96	2,580	206.40			11,092	887.36	124.3	9.95
Stone	Cubic yards	1,789.29	3,542.80	525.69	1,040.86	201.4	398.77	2,516.38	4,982.43	28.2	55.86
Wire, No. 12	Pounds	13,000	419.00	5,878	205.73	550	19.25	19,428	643.98	217.8	7.22
Wire strand, ¾ inch	do	26,670	687.61	8,900	212.51			35,570	850.12	398.7	9.53
Spikes and nails	do	19,365	427.88	6,020	129.97			25,385	557.85	284.5	6.25
Washers	do	184	3.50					184	3.50	2	.04
Bolts	Number	3,518	157.85	1,173	52.60			4,691	210.45	52.5	2.36
Clamps	do	480	50.16	140	15.96			620	66.12	6.9	.74
Coal	Bushels	13,121	1,302.45	6,560	651.22			19,681	1,953.67	220.6	21.91
Oils and engineer supplies			100.66		50.23				150.89		1.69
Rope	Pounds		199.07		66.36				265.43		2.97
Miscellaneous			85.80		41.35		4.86		132.01		1.48
Total			26,701.73		10,875.34		1,508.81		39,085.88		438.18

144 squares bank work; cost $10.48 per square (100 square feet).
6,600 linear feet of dikes built at Point Pleasant, Mo., 2,320 linear feet of dikes built at Cherokee Crossing; total, 8,920 linear feet; cost $4.38 per linear foot.

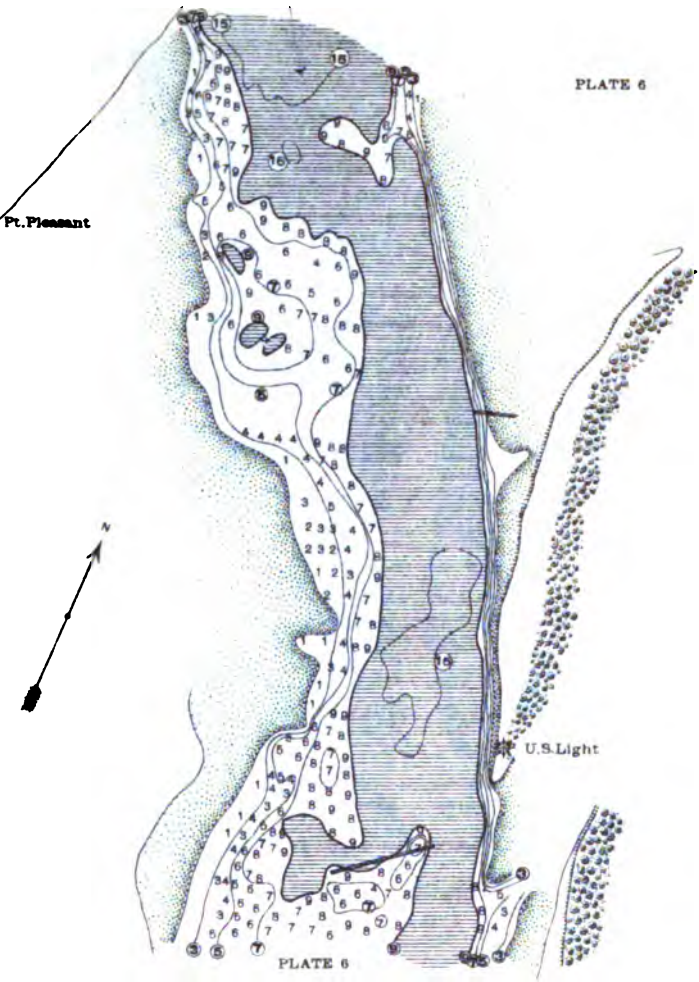




ARKA
PLAQUEMINE
VICKSBURG
RED RIVER LDG.
CARROLLTON
116 44
21.06
23.85
29.91
given for 1900.

Eng 56 2

PLATE 6



MISSISSIPPI RIVER COMMISSION.

MAP OF

POINT PLEASANT CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 23-24 and 28-29, 1909.

BEFORE DREDGING.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey, August 23-24 was 11.0 feet or 8.8 feet above mean low water; August 28-29 was 8.3 feet or 6.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

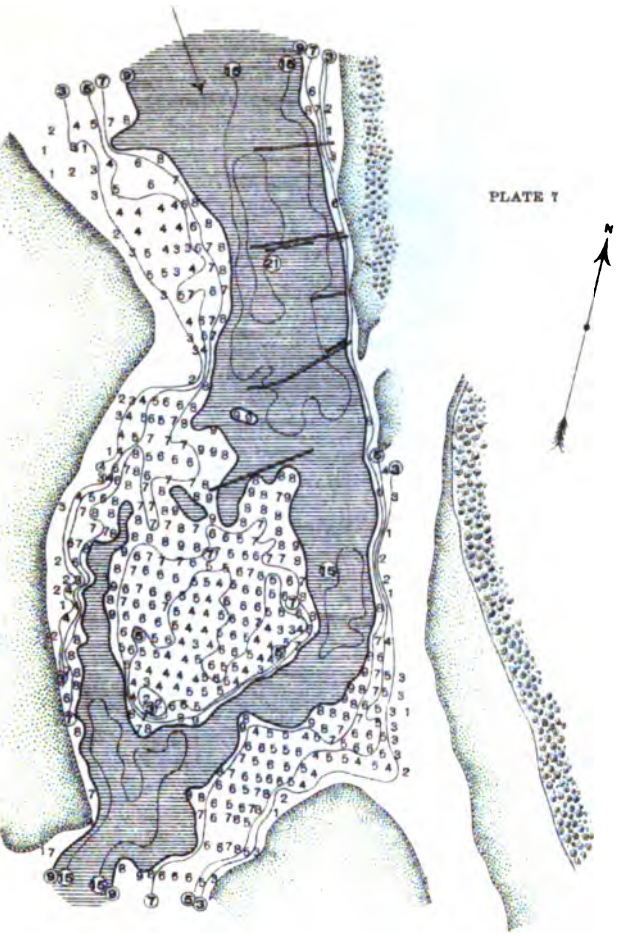


PLATE 7

PLATE 7

MISSISSIPPI RIVER COMMISSION.

MAP OF

POINT PLEASANT CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 8, 1899.

FOUR DAYS BEFORE DREDGING.

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 3.5 feet or 1.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

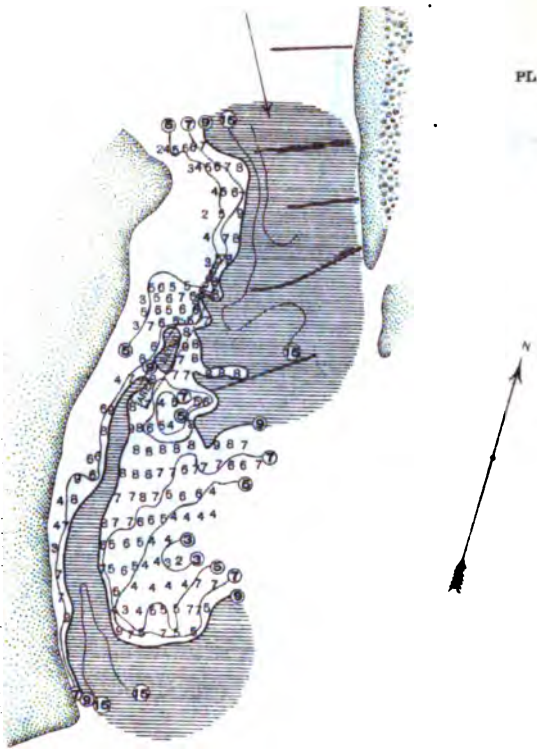


PLATE 8

MISSISSIPPI RIVER COMMISSION.

MAP OF

POINT PLEASANT CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 17, 1899.

ONE DAY AFTER DREDGING BY *BETA*.

SCALE OF FEET.

1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 2.9 feet or 0.7 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

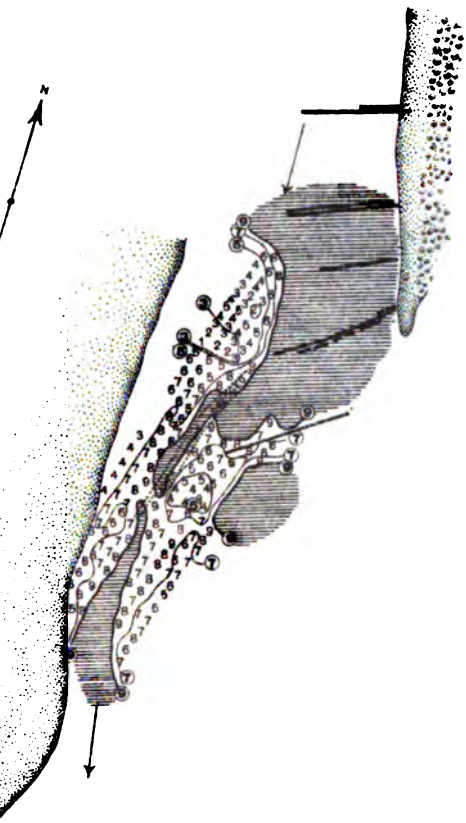


PLATE 9

MISSISSIPPI RIVER COMMISSION.

MAP OF

POINT PLEASANT CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 25, 1930.

TWO DAYS AFTER SECOND DREDGING BY DSTA.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 2.2 feet or 0.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 10

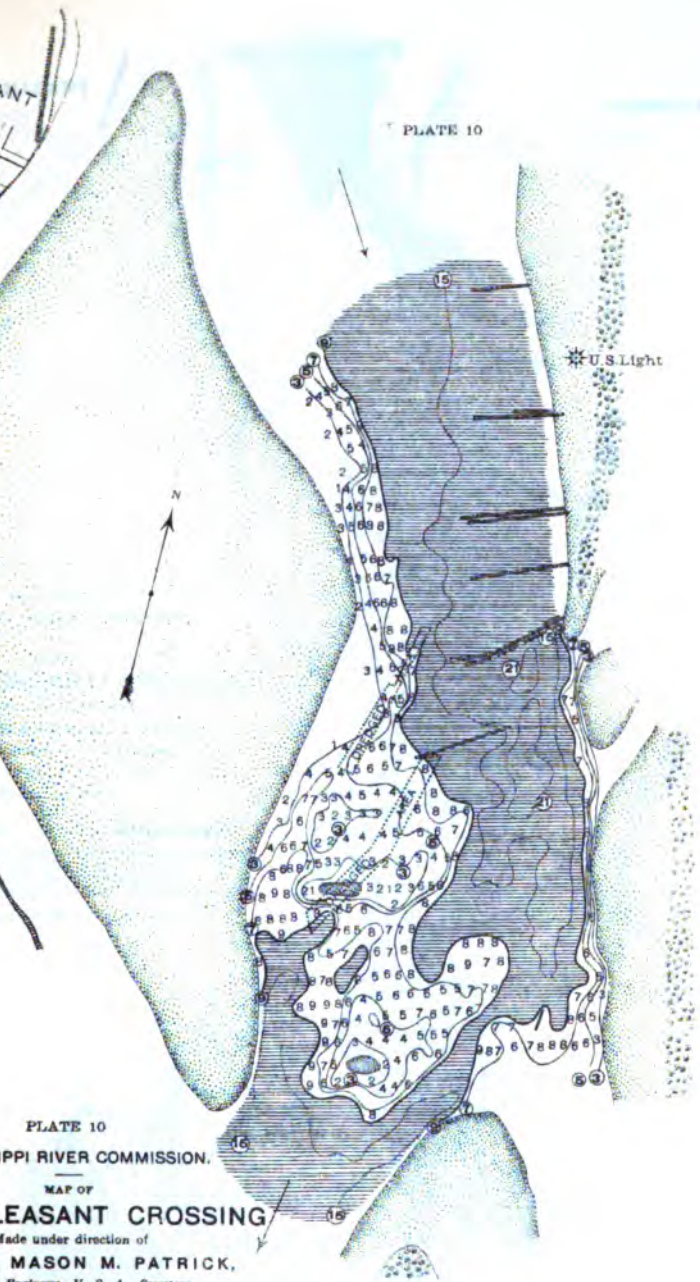


PLATE 10

IPPI RIVER COMMISSION.

MAP OF

LEASANT CROSSING

Made under direction of

MASON M. PATRICK,

Engineers, U. S. A., Secretary.

ey of December 13, 1899.

FEEN DAYS AFTER DREDGING.

SCALE OF FEET.

for soundings and contours are expressed in feet mean low water on the New Madrid gage, which f 2.2 feet.

was 5.3 feet or 3.1 feet above mean low water bars above mean low water.

Eng 56 2

EASANT

PLATE 10 A.

PI RIVER COMMISSION.

MAP OF

EASANT CROSSING

ade under direction of

MASON M. PATRICK,

Engineers, U. S. A., Secretary.

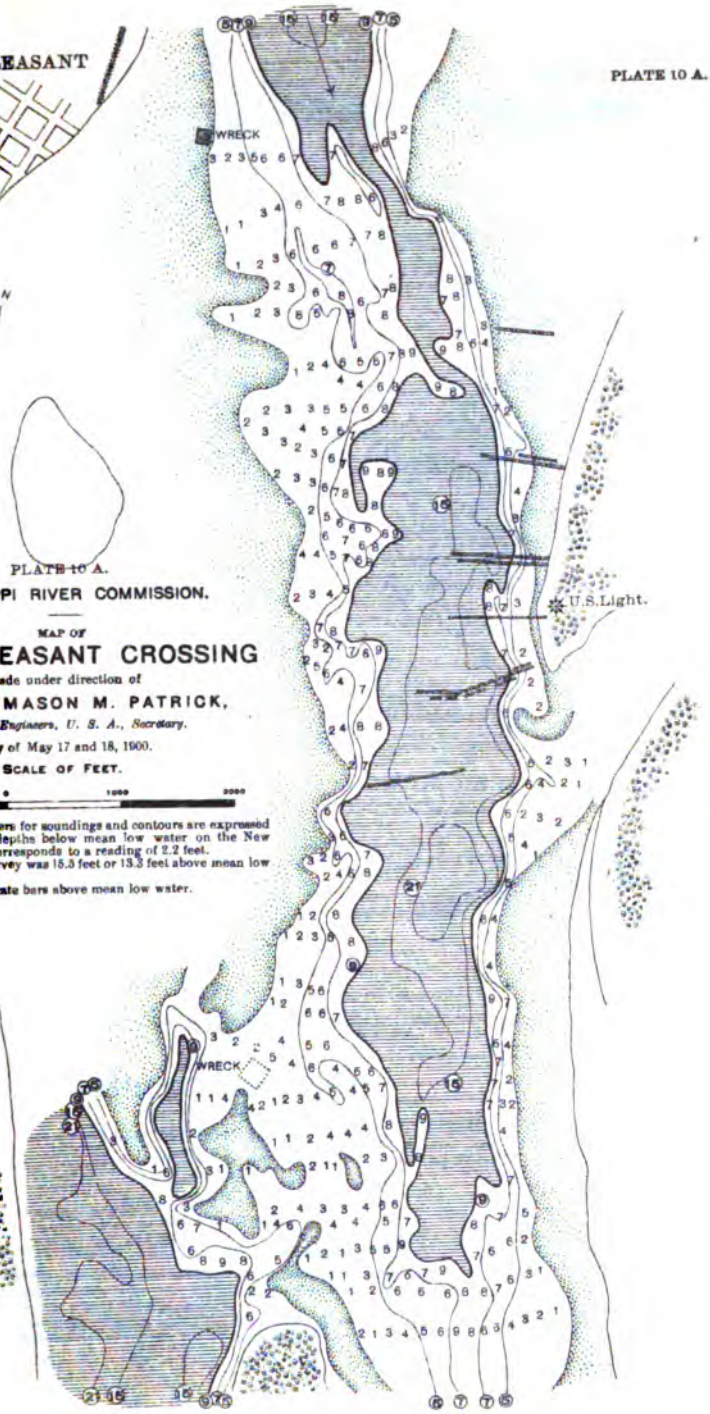
y of May 17 and 18, 1900.

SCALE OF FEET.

0 1000 2000

ers for soundings and contours are expressed
epths below mean low water on the New
rresponds to a reading of 2.2 feet.
vey was 15.5 feet or 13.3 feet above mean low

ate bars above mean low water.



Eng 56 2

PLATE 11

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHEROKEE CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 1, 1899.

NINE DAYS BEFORE DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 7.1 feet or 4.9 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 12

PLATE 13

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHEROKEE CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 23, 1930.

ONE DAY AFTER DREDGING.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 5.2 feet or 3.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 13

PLATE 13

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHEROKEE CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 2, 1890.

DURING DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 4.2 feet or 2.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

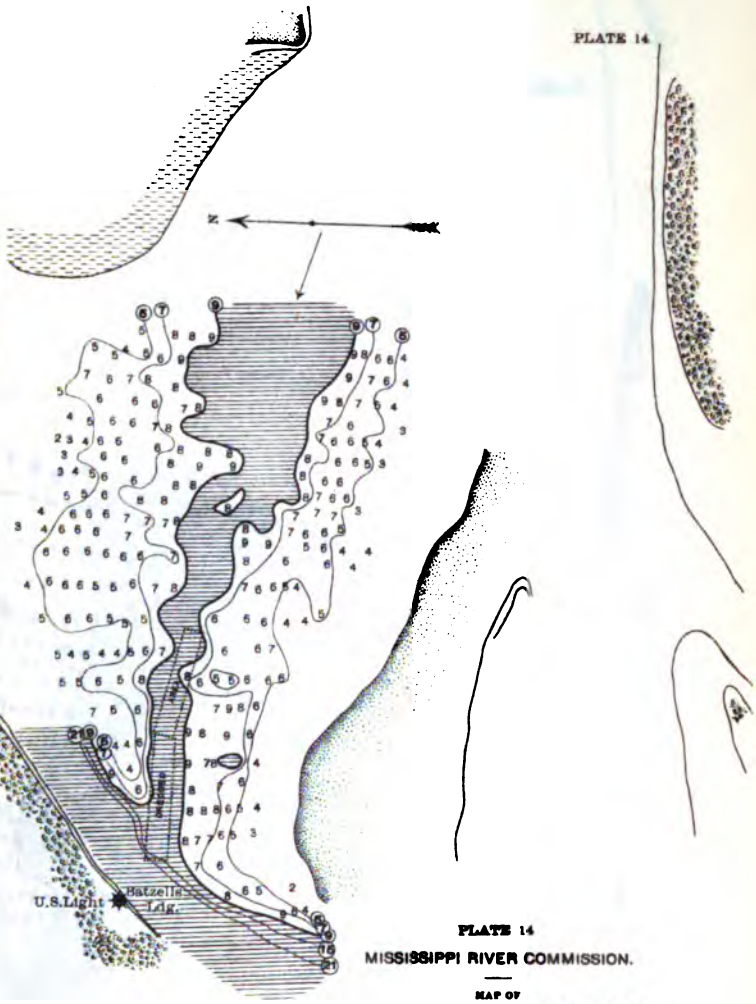


PLATE 14

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHEROKEE CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 7, 1899.

ONE DAY AFTER SECOND DREDGING BY *EPSILON*.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 3.5 feet or 1.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 15

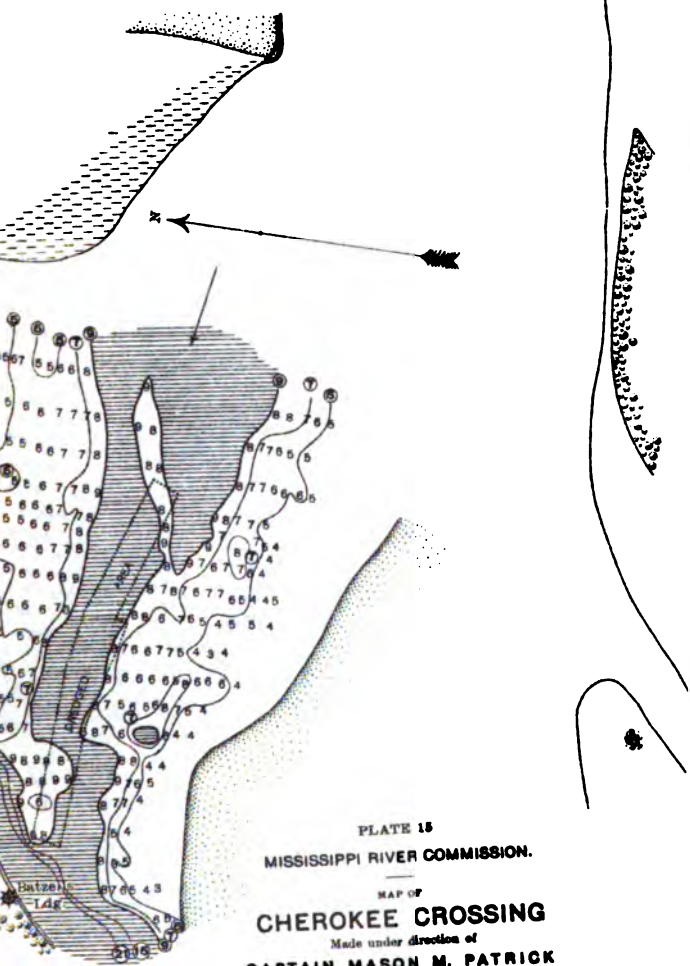


PLATE 15

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHEROKEE CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK

Corps of Engineers, U. S. A., Secretary.

Survey of October 27, 1909.

TWENTY-ONE DAYS AFTER DREDGING.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.5 feet.

Gage at time of survey was 2.4 feet or 0.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

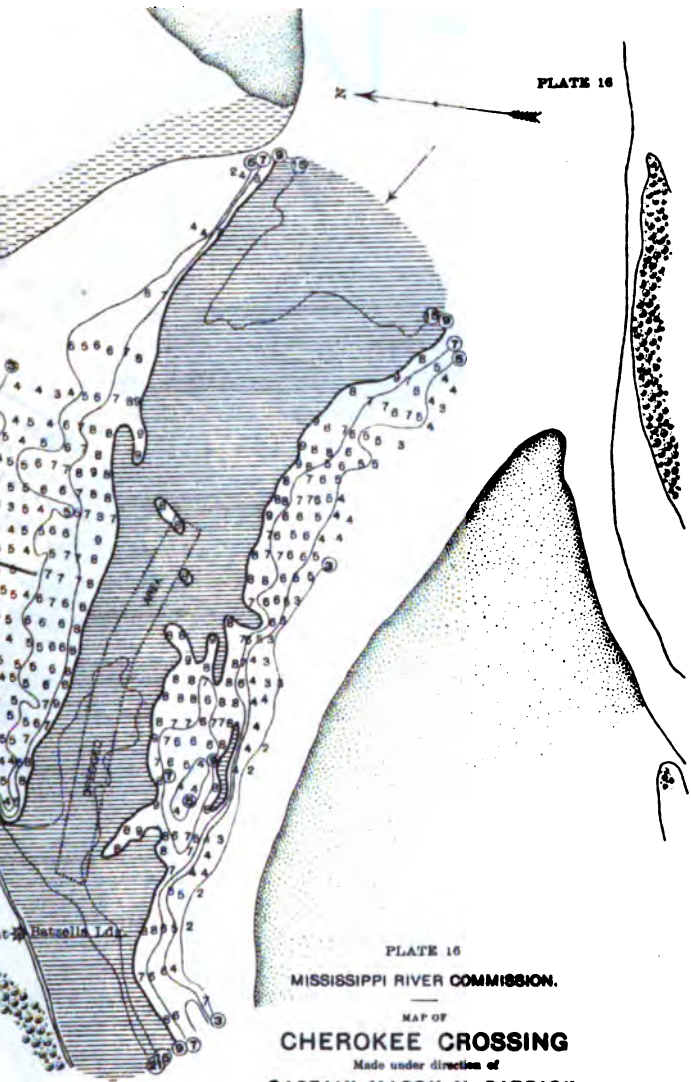


PLATE 16

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHEROKEE CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of December 14-15, 1899.

THIRTY-NINE DAYS AFTER FINAL DREDGING.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 5.5 feet or 3.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 16 A.

PLATE 16 A.

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHEROKEE CROSSING,

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of May 19, 1900.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the New Madrid gage, which corresponds to a reading of 2.2 feet.

Gage at time of survey was 14.6 feet or 12.4 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 17

MISSISSIPPI RIVER COMMISSION.

MAP OF

HICKMAN CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 3-4, 1909.

SEVENTEEN DAYS BEFORE DREDGING.

SCALE OF FEET.

2400 1600 1200 800 0 2400 4800

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 11.6 feet or 11.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 18

MISSISSIPPI RIVER COMMISSION.

MAP OF

HICKMAN CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 14-16, 1909.

SIX DAYS BEFORE DREDGING.

SCALE OF FEET.

700 500 250 0 1000 2000

The numbers for soundings and contours are expressed in feet depths below mean low water, on the Cottonwood Point gage, sponds to a reading of 0.4 feet.

time of survey was 12.0 feet and 12.4 feet or 11.6 feet and 12.0 mean low water.

areas indicate bars above mean low water.

Eng 56 2

PLATE 19

MISSISSIPPI RIVER COMMISSION.

MAP OF

HICKMAN CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 4, 1899.

THREE DAYS AFTER DREDGING

SCALE OF FEET.

1500 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 3.3 feet or 2.9 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

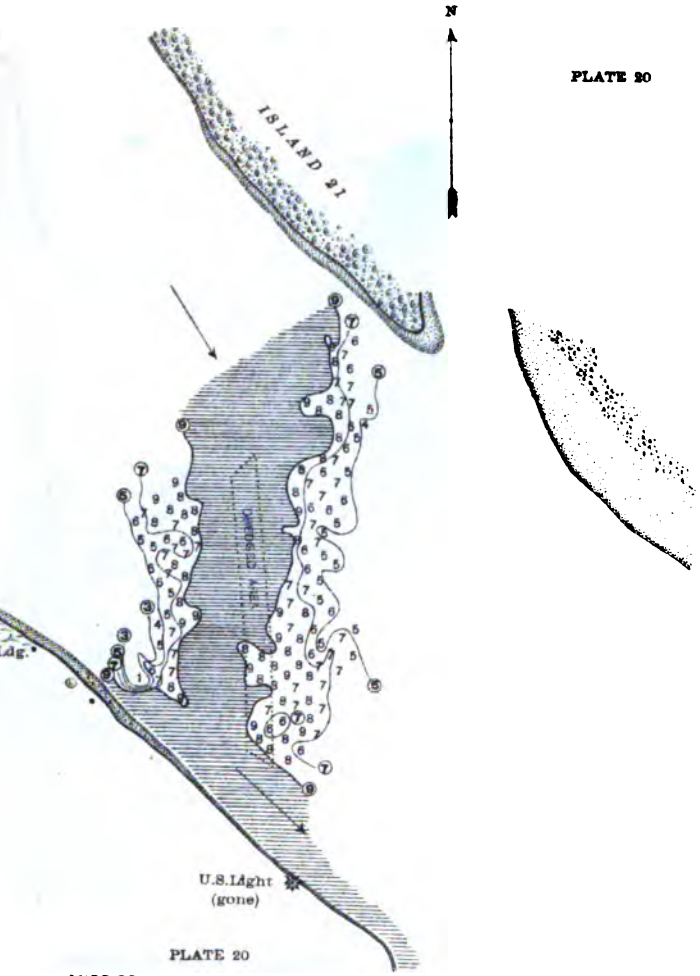


PLATE 20

MISSISSIPPI RIVER COMMISSION.

MAP OF

HICKMAN CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 16, 1909.

FIFTEEN DAYS AFTER DREDGING.

SCALE OF FEET.

1000 700 500 200 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet
indicate depths below mean low water, on the Cottonwood Point gage,
ch corresponds to a reading of 0.4 feet.
Gage at time of survey was 2.0 feet or 2.6 feet above mean low water.
Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 21

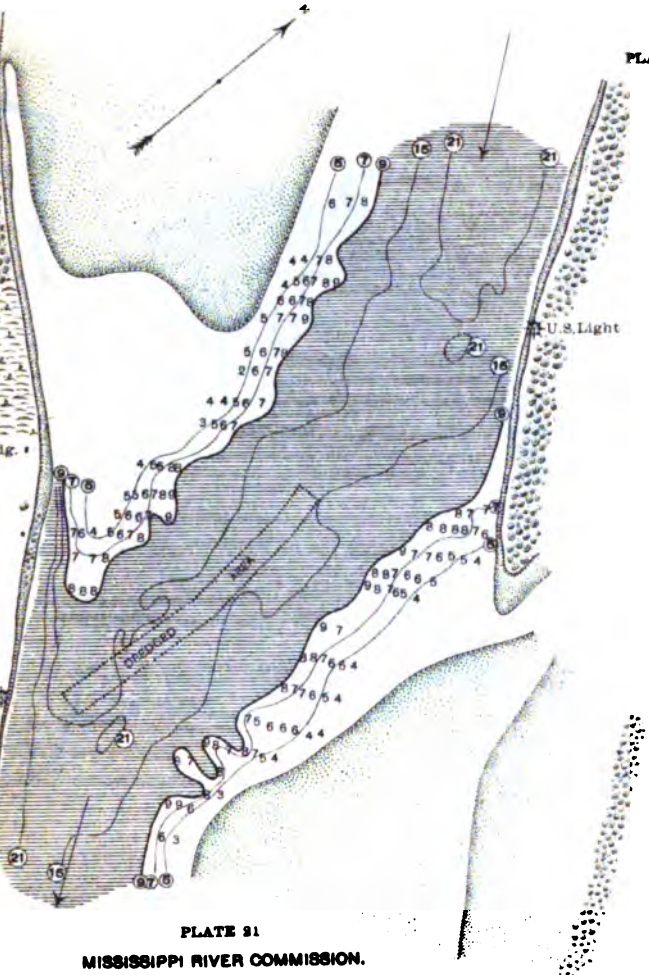


PLATE 21

MISSISSIPPI RIVER COMMISSION.

MAP OF

HICKMAN CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of December 16, 1899.

ONE HUNDRED AND SIX DAYS AFTER DREDGING.

SCALE OF FEET.

1000 700 500 300 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Cottonwood Point gage, which corresponds to a reading of 0.4 feet.

Gage at time of survey was 3.4 feet or 3.0 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

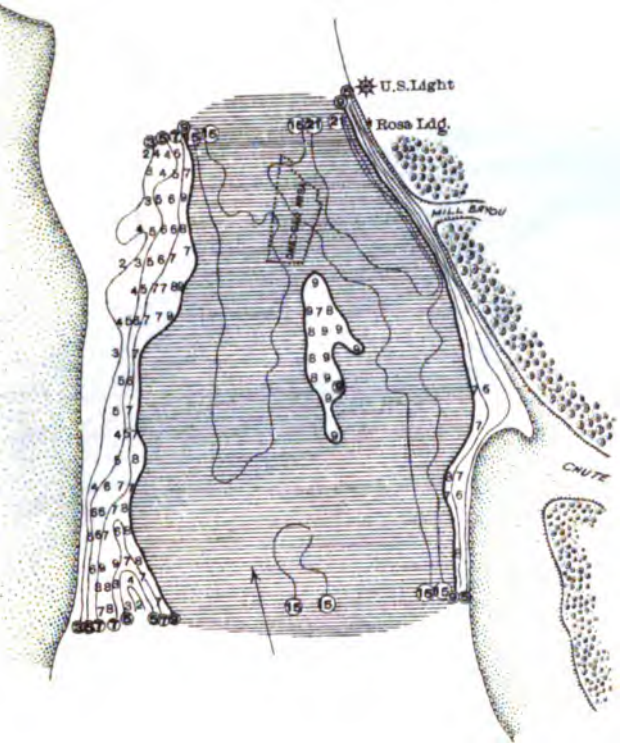


PLATE 22

MISSISSIPPI RIVER COMMISSION.

MAP OF

GOLD DUST CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of December 19, 1908.

FORTY-SEVEN DAYS AFTER DREDGING.

SCALE OF FEET.

1000 700 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 8.0 feet or 4.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

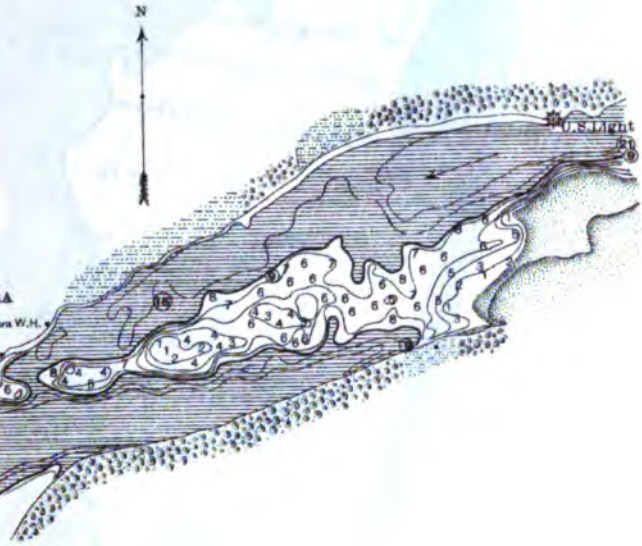


PLATE 23

MISSISSIPPI RIVER COMMISSION.

MAP OF

LUXORA CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of July 22, 1899.

BEFORE DREDGING.

SCALE OF FEET.

2400 1600 1200 800 0 2400 4800

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 14.3 feet or 10.4 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

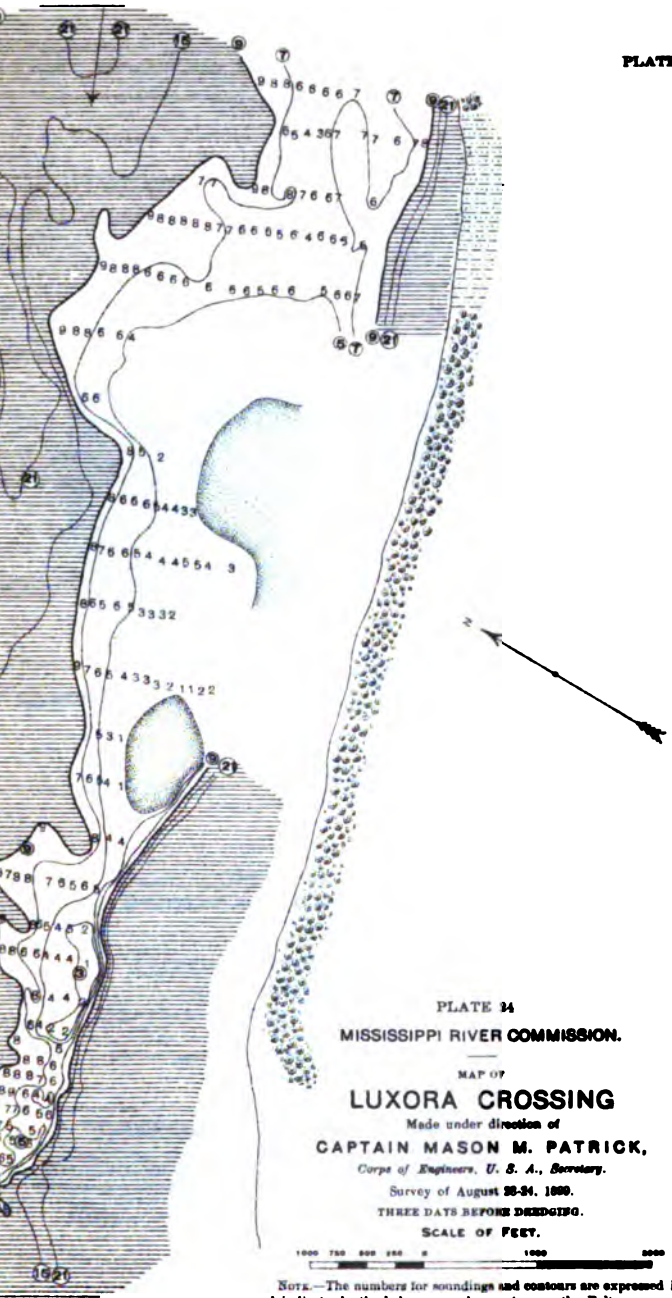


PLATE 24

MISSISSIPPI RIVER COMMISSION.

MAP OF

LUXORA CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 23-24, 1929.

THREE DAYS BEFORE DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 10.7 feet or 6.8 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

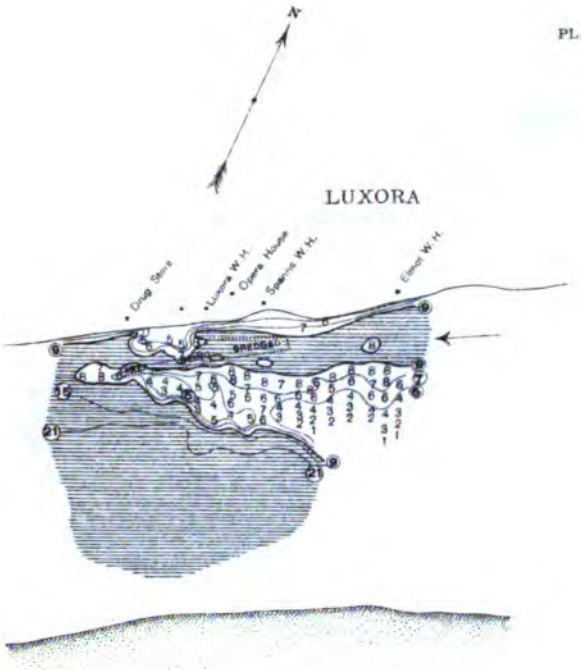


PLATE 25

MISSISSIPPI RIVER COMMISSION.

MAP OF

LUXORA CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 4, 1899

DURING DREDGING.

SCALE OF FEET.

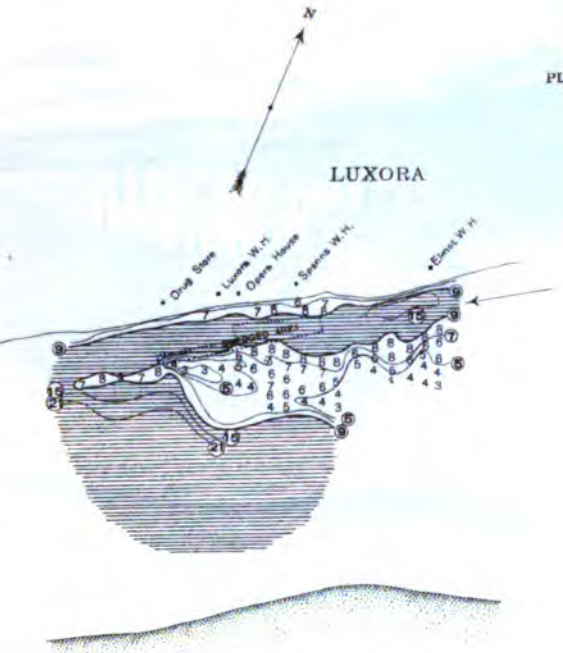
1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 6.1 feet or 2.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2



ISLAND NO. 30

PLATE 26

MISSISSIPPI RIVER COMMISSION.

MAP OF

LUXORA CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 18, 1899.

SIX DAYS AFTER DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 5.0 feet or 1.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 27

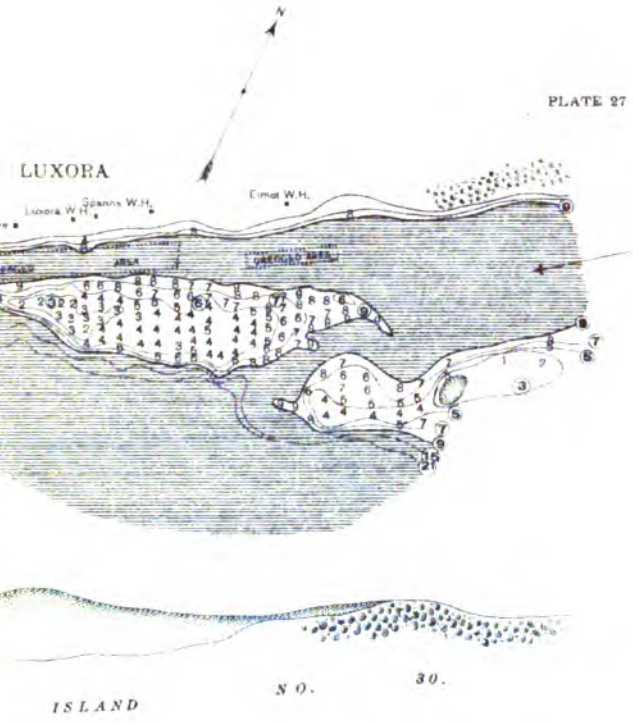


PLATE 27

MISSISSIPPI RIVER COMMISSION.

MAP OF

LUXORA CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of December 18, 1899.

FORTY DAYS AFTER DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

Note.—The numbers for soundings and contours are expressed in feet
d indicate depths below mean low water, on the Fulton gage, which
rresponds to a reading of 3.9 feet.
Gage at time of survey was 7.3 feet or 3.4 feet above mean low water.
Dotted areas indicate bars above mean low water.

Eng 56 2

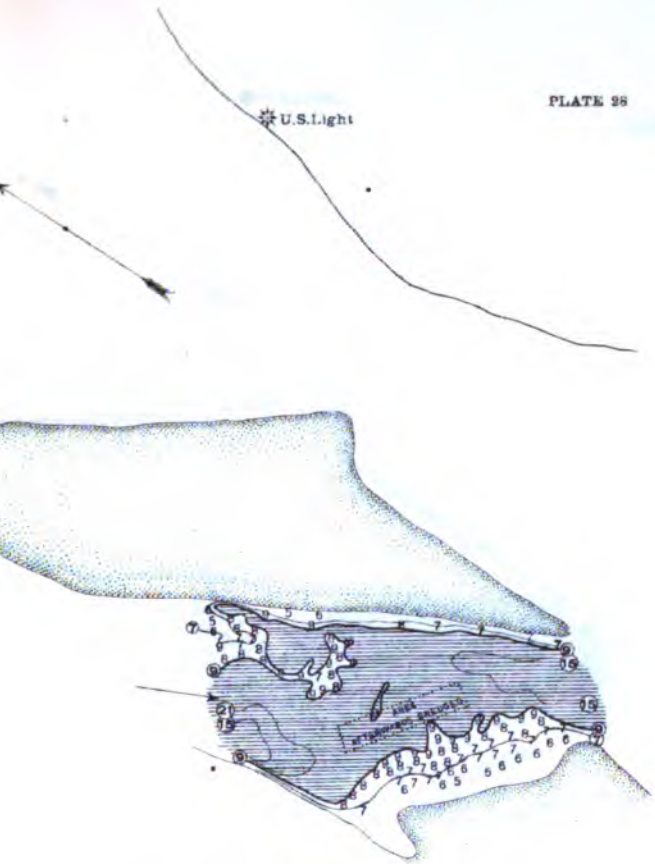


PLATE 28

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHANNEL IN VICINITY OF OSCEOLA LANDING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 10, 1899.

IMMEDIATELY BEFORE DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 3.1 feet or 0.8 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

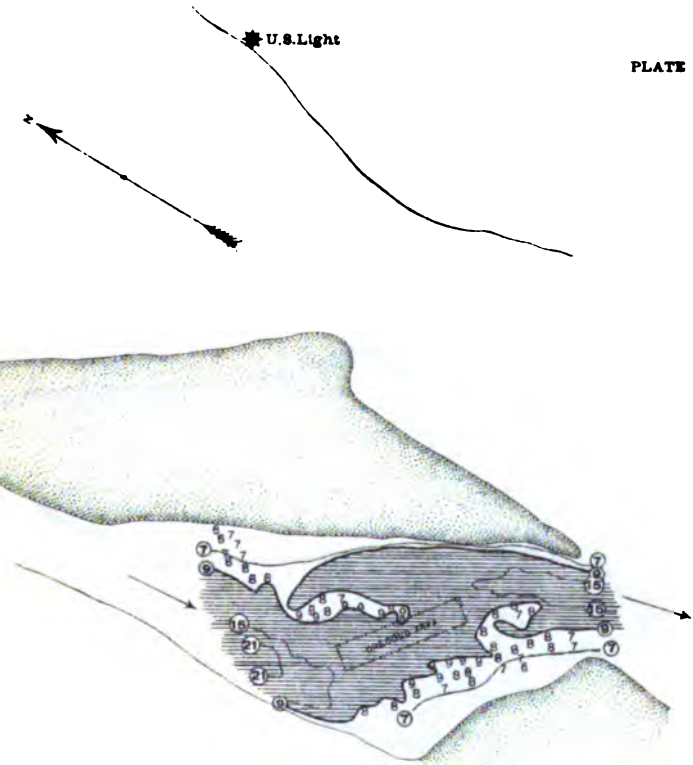


PLATE 29

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHANNEL IN VICINITY OF OSCEOLA LANDING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 12, 1899.

IMMEDIATELY AFTER DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 2.8 feet or 1.1 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

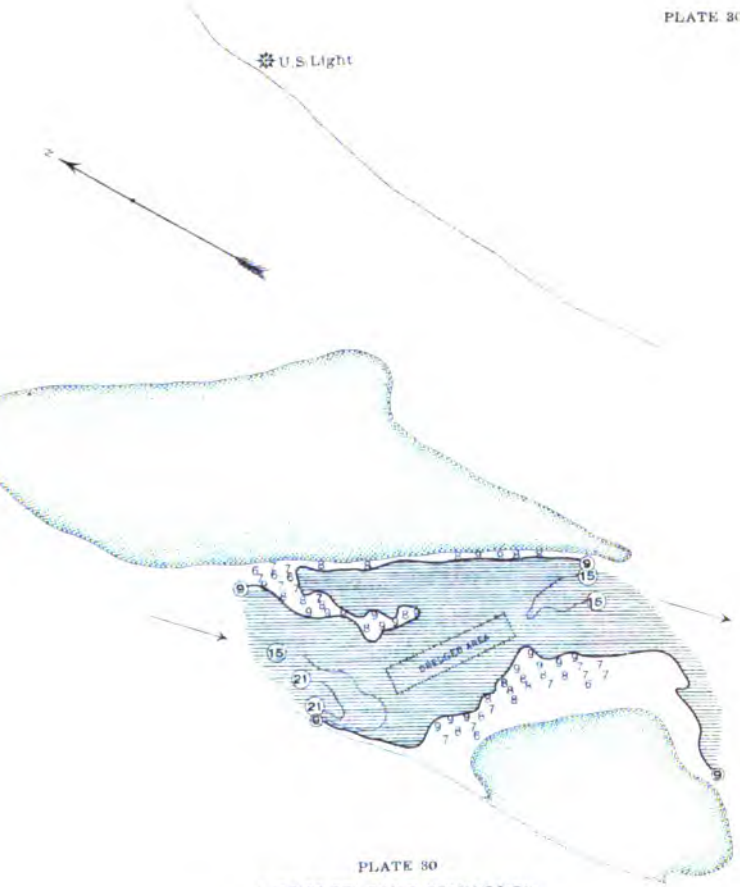


PLATE 30

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHANNEL IN VICINITY OF OSCEOLA LANDING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary

Survey of November 2, 1899

TWENTY DAYS AFTER DREDGING

SCALE OF FEET

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 2.3 feet or 1.6 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 81

MISSISSIPPI RIVER COMMISSION.

MAP OF

CHANNEL IN VICINITY OF OSCEOLA LANDING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of December 20, 1899.

SIXTY-EIGHT DAYS AFTER DREDGING.

SCALE OF FEET

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 8.5 feet or 4.6 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

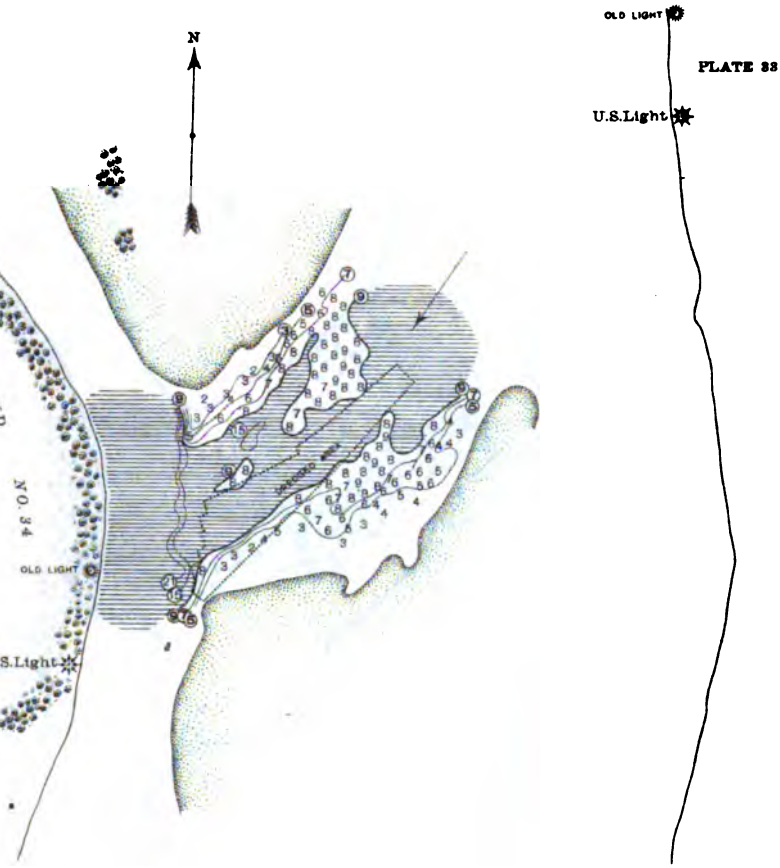


PLATE 33

PLATE 33

MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER CROSSING ISLAND 34

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 15, 1899.

TWO DAYS AFTER DREDGING FIRST TIME.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 5.2 feet or 1.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 33

PLATE 33

MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER CROSSING ISLAND 34

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 15, 1899.

TWO DAYS AFTER DREDGING FIRST TIME.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 5.2 feet or 1.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 34

MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER CROSSING ISLAND 34

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 30, 1899.

SEVENTEEN DAYS AFTER DREDGING FIRST TIME.

SCALE OF FEET.

1000 600 200 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 4.4 feet or 0.5 foot above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 35

MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER CROSSING ISLAND 34

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 19, 1899.

TWO DAYS BEFORE DREDGING SECOND TIME.

SCALE OF FEET.

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 2.9 feet or 1.0 foot below mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

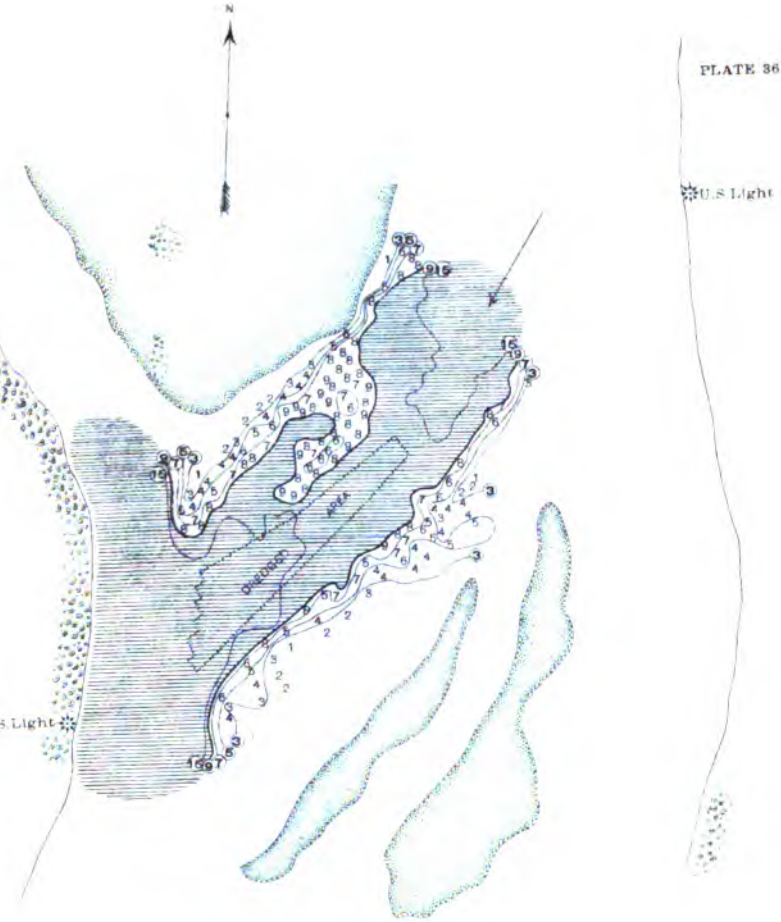


PLATE 36

MISSISSIPPI RIVER COMMISSION.

MAP OF

UPPER CROSSING ISLAND 34

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of December 21, 1899.

SIXTY DAYS AFTER DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Fulton gage, which corresponds to a reading of 3.9 feet.

Gage at time of survey was 8.5 feet or 4.6 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

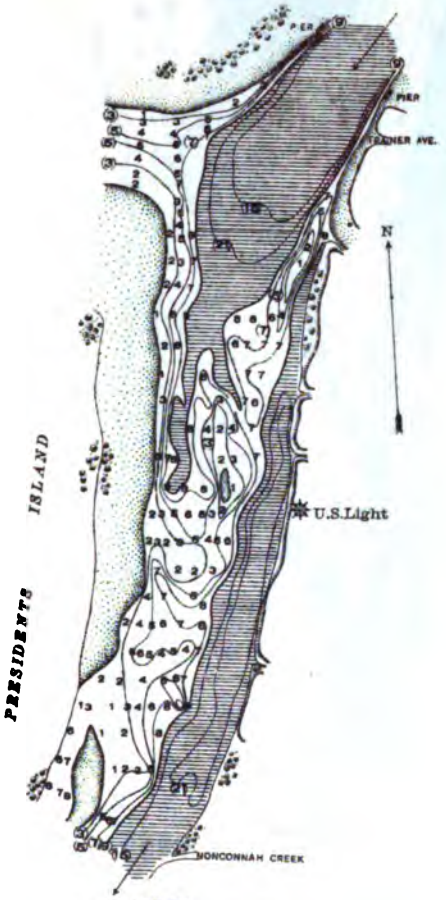


PLATE 37

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND BAR

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 8-9, 1899.

NINETEEN DAYS BEFORE DREDGING.

SCALE OF FEET.

Nore.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 9.6 feet or 7.8 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 38

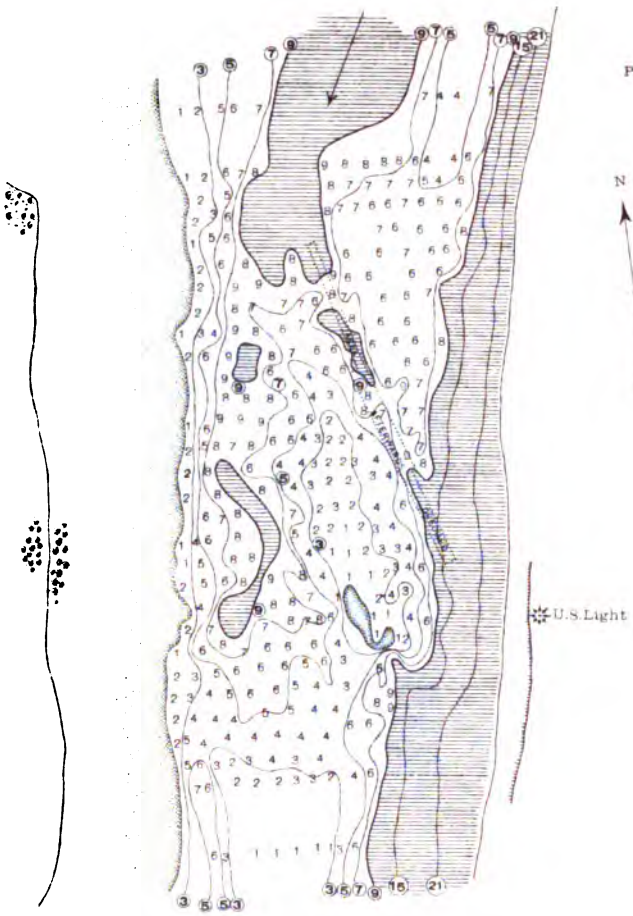


PLATE 38

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND BAR

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 21, 1899

SEVEN DAYS BEFORE DREDGING.

SCALE OF FEET

1000 750 500 250 0 1500 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 10.1 feet or 8.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

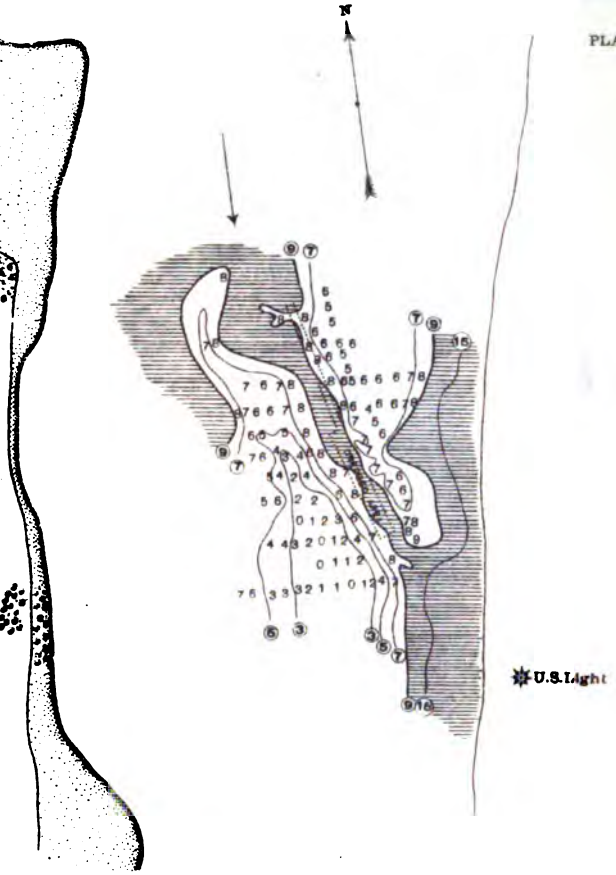


PLATE 39

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND BAR

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 1, 1929.

DURING DREDGING.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.6 feet.

Gage at time of survey was 5.1 feet or 3.3 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

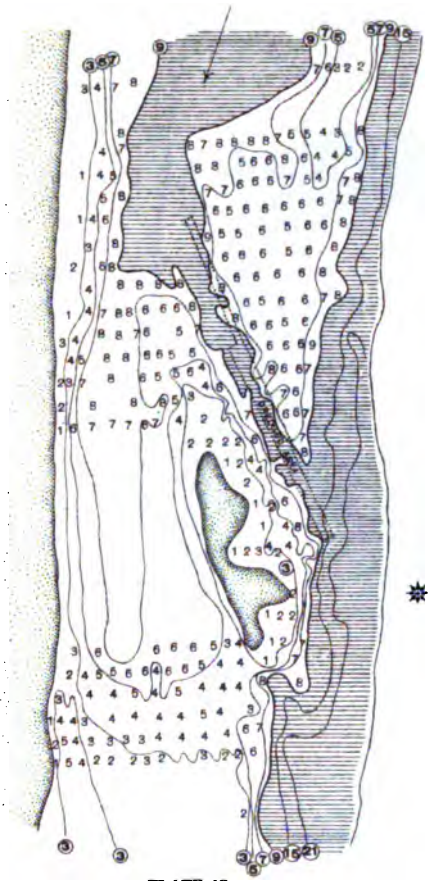


PLATE 40

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND BAR

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 3-4, 1899.

ONE DAY AFTER DREDGING.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 4.4 feet or 2.6 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 53 2

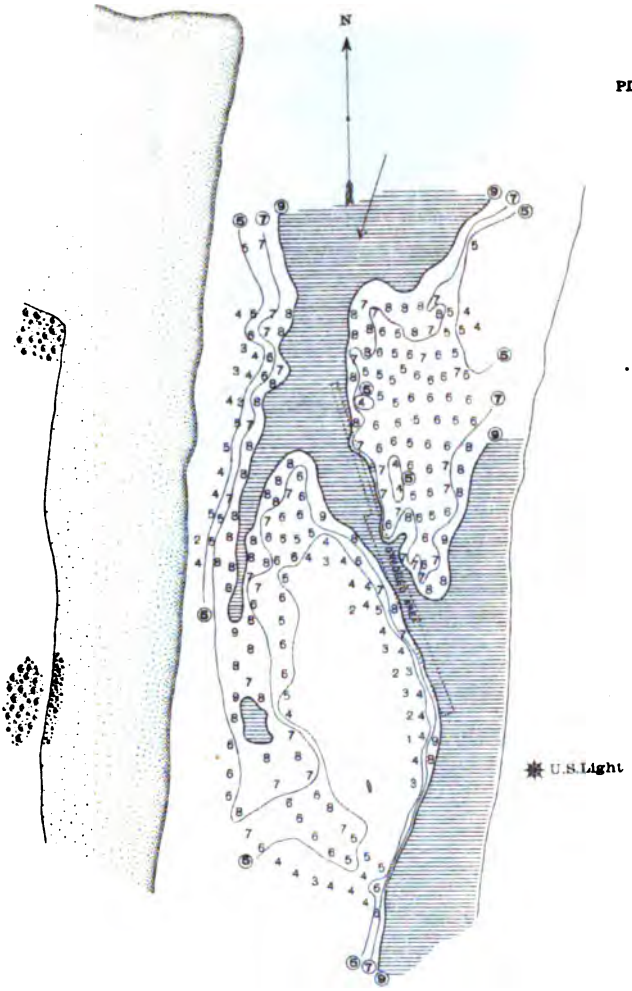


PLATE 41

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND BAR

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 18, 1899.

FIFTEEN DAYS AFTER DREDGING.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 2.9 feet or 1.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 42

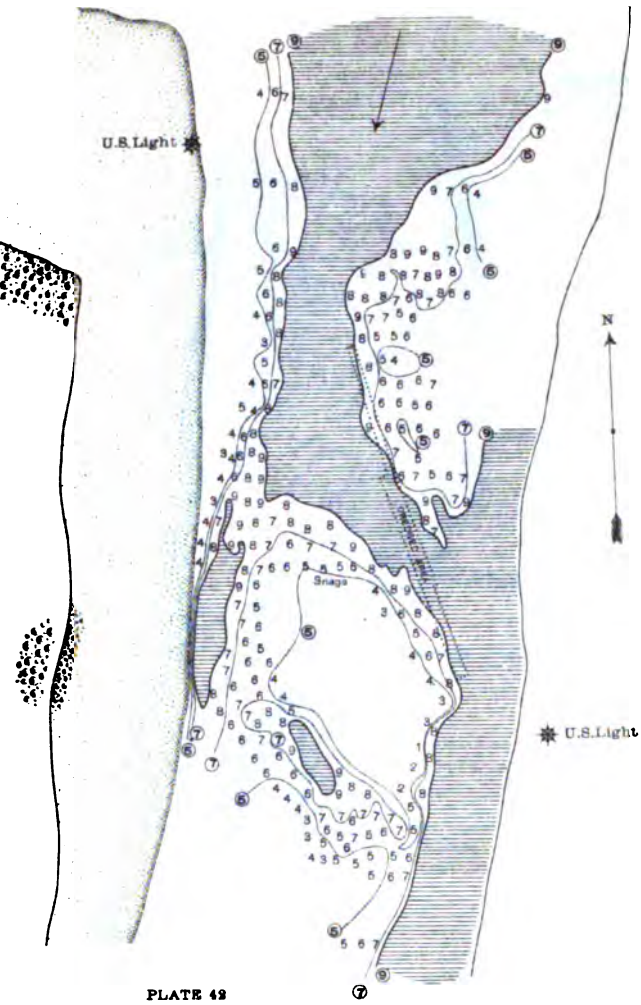


PLATE 42

MISSISSIPPI RIVER COMMISSION.

MAP OF

PRESIDENTS ISLAND BAR

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of November 24, 1899.

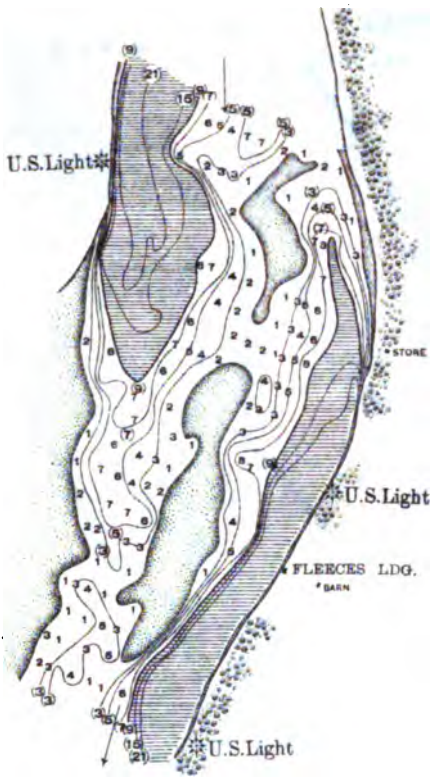
EIGHTY-TWO DAYS AFTER DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

ors.—The numbers for soundings and contours are expressed in feet
dicate depths below mean low water, on the Memphis gage, which
ponds to a reading of 1.8 feet.
ge at time of survey was 3.2 feet or 1.4 feet above mean low water.
otted areas indicate bars above mean low water.

Eng 56 2



N

PLATE 48

MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of July 25-27, 1929.

SEVEN DAYS BEFORE DREDGING.

SCALE OF FEET.

2000 1000 1000 000 0 2000 4000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 12.2 feet or 10.4 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

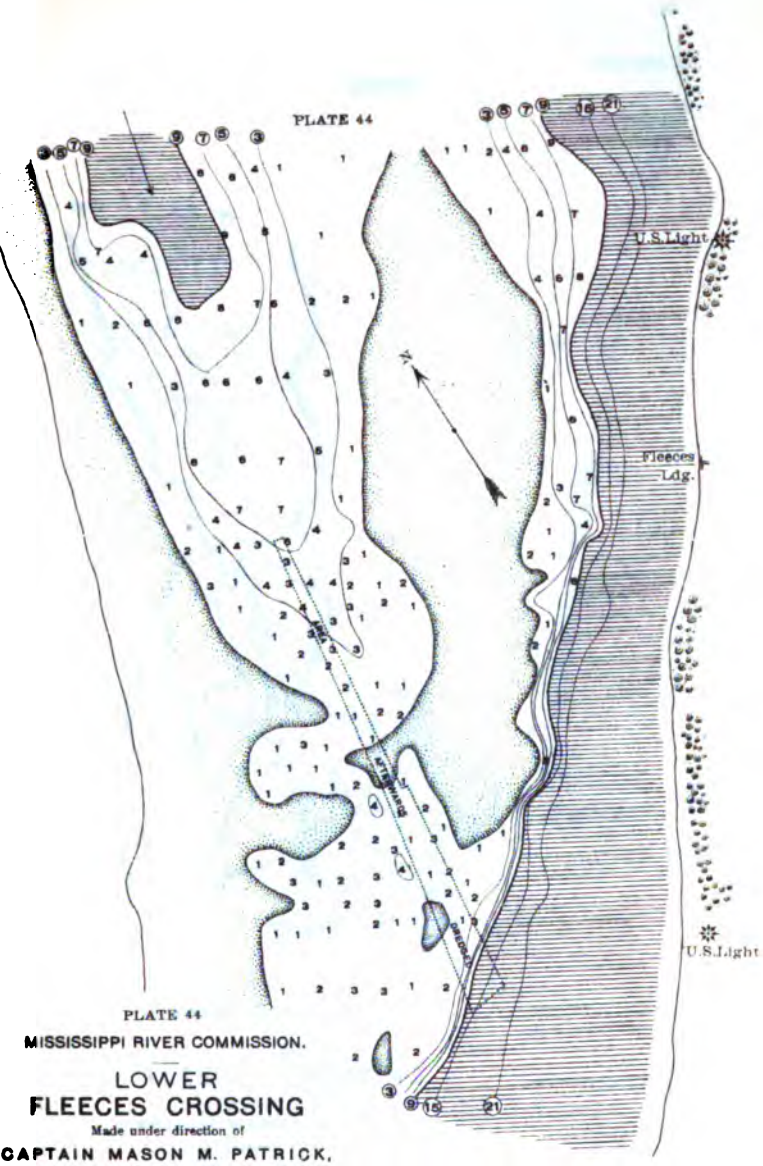


PLATE 44

MISSISSIPPI RIVER COMMISSION.

LOWER FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of July 31 and August 1, 1899.

ONE DAY BEFORE DREDGING.

SCALE OF FEET.

0 500 500 500 0 1000 2000

—The numbers for soundings and contours are expressed in feet
ato depths below mean low water on the Memphis gage, which
ds to a reading of 1.8 feet.
t time of survey was 11.0 feet or 9.2 feet above mean low water
d areas indicate bars above mean low water.

Eng 56 2

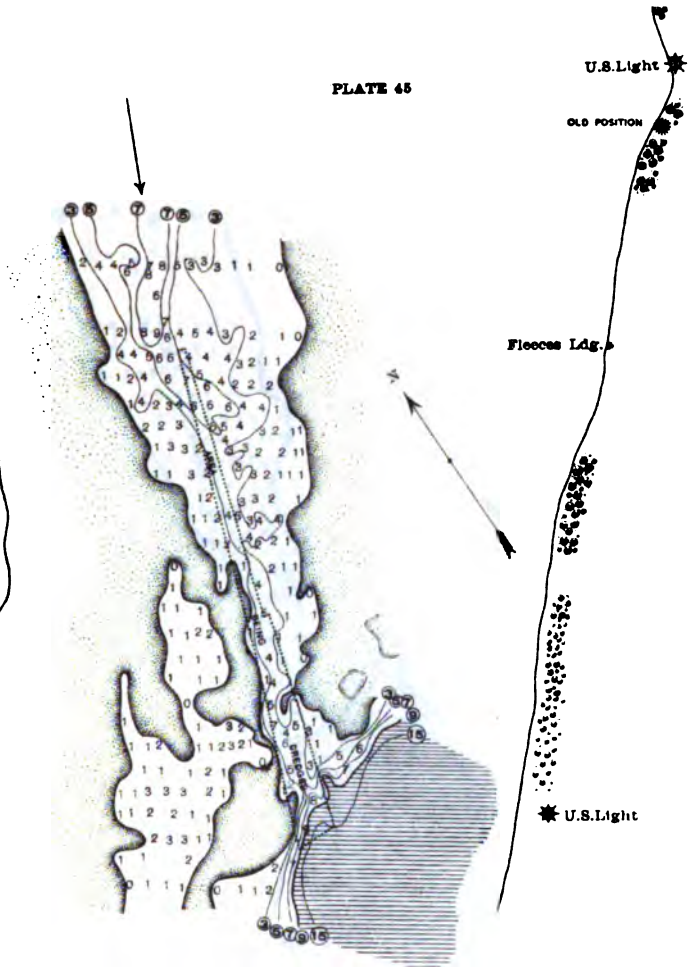


PLATE 45

MISSISSIPPI RIVER COMMISSION.

LOWER
FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 16, 1899.

DURING DREDGING.

SCALE OF FEET.

1000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 11.0 feet or 9.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 46

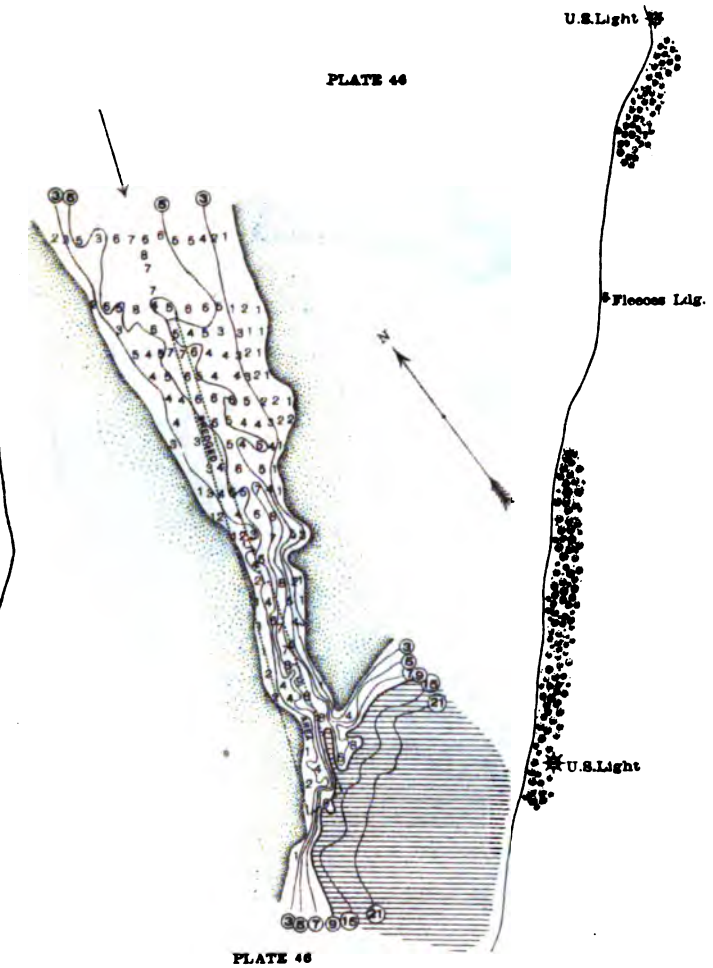


PLATE 46

MISSISSIPPI RIVER COMMISSION.

LOWER
FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of August 27, 1899.

ONE DAY AFTER DREDGING.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 7.0 feet or 5.2 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

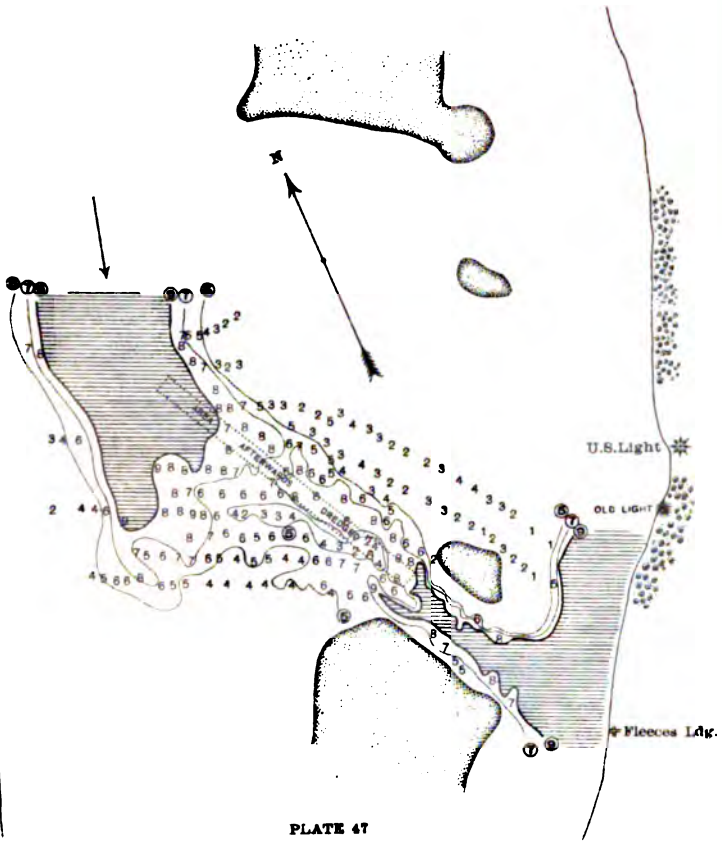


PLATE 47

MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 8, 1899.

DURING DREDGING.

SCALE OF FEET.

1000 500 000 000 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 3.6 feet or 1.8 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

U.S.Light

PLATE 48

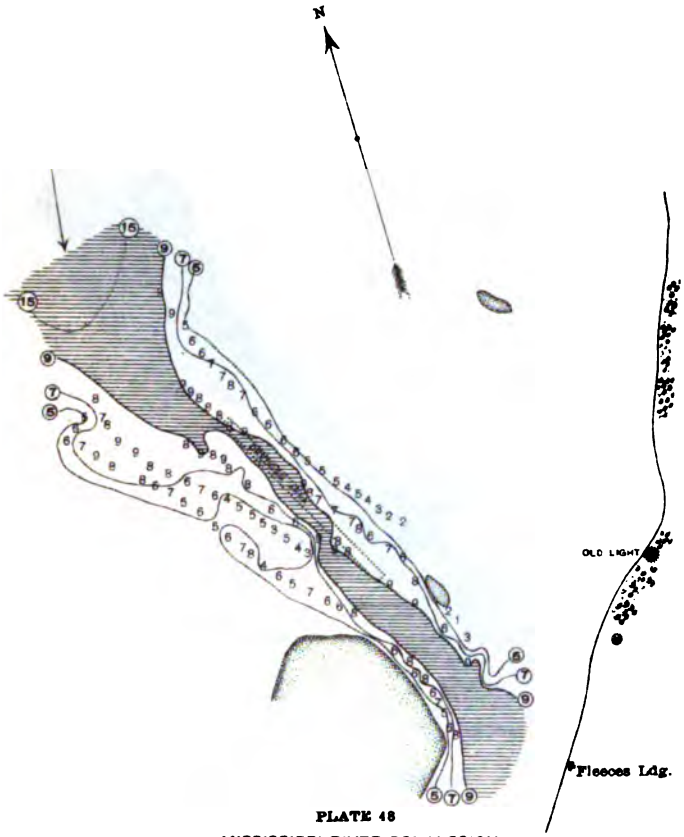


PLATE 48

MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 13, 1899.

DURING DREDGING.

SCALE OF FEET.

1000 750 500 250 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 2.9 feet or 1.1 feet above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

U.S.Light

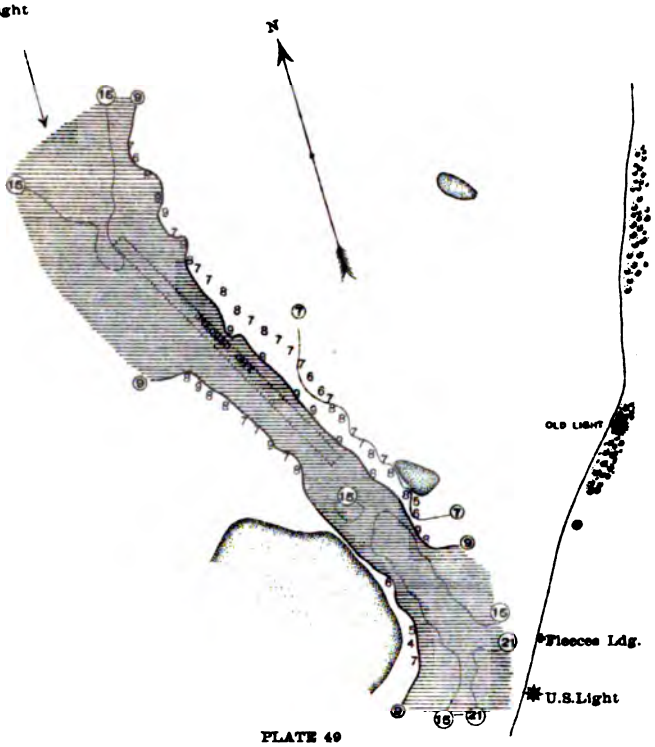


PLATE 49

MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of September 19, 1899.

THREE DAYS AFTER DREDGING.

SCALE OF FEET.

1000 700 500 300 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 2.5 feet or 0.7 foot above mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2

PLATE 50

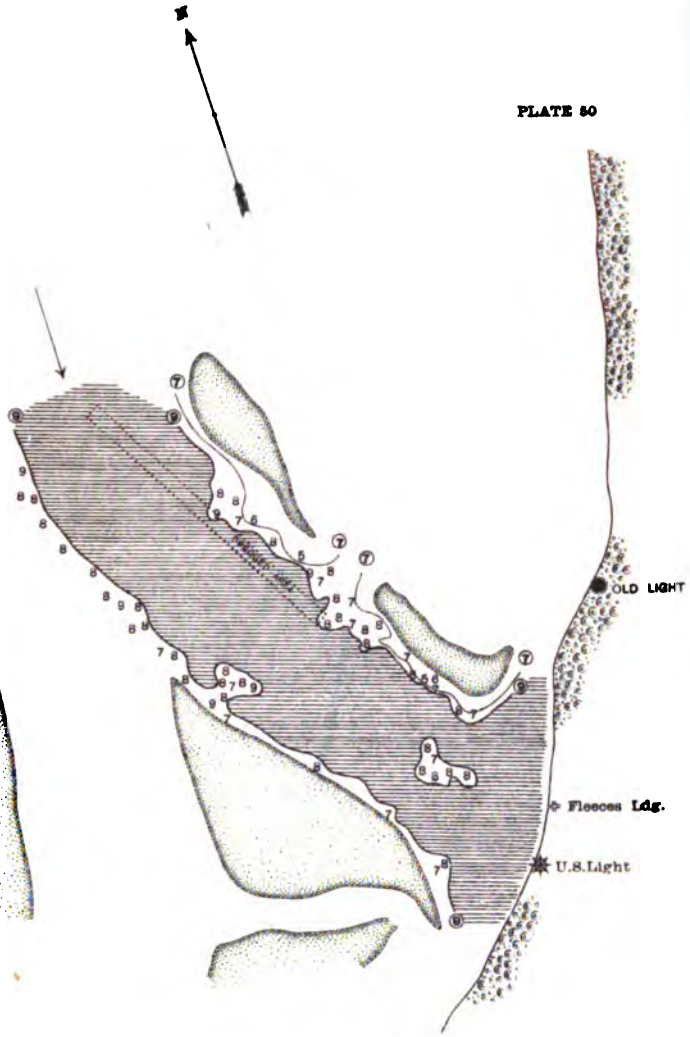


PLATE 50

MISSISSIPPI RIVER COMMISSION.

MAP OF

FLEECES CROSSING

Made under direction of

CAPTAIN MASON M. PATRICK,

Corps of Engineers, U. S. A., Secretary.

Survey of October 21, 1899.

THIRTY-FIVE DAYS AFTER DREDGING.

SCALE OF FEET.

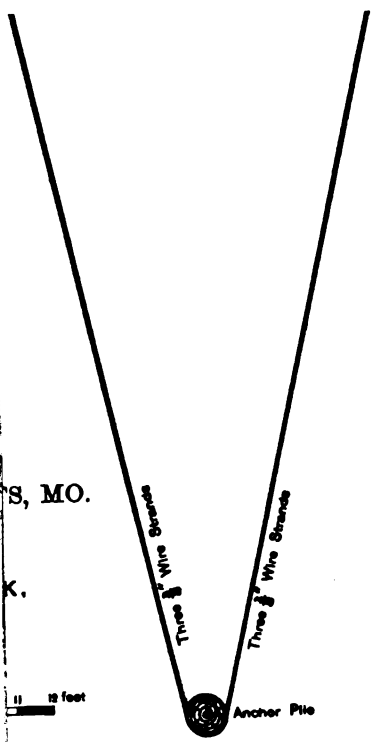
1000 500 000 500 0 1000 2000

NOTE.—The numbers for soundings and contours are expressed in feet and indicate depths below mean low water, on the Memphis gage, which corresponds to a reading of 1.8 feet.

Gage at time of survey was 0.0 foot or 1.8 feet below mean low water.

Dotted areas indicate bars above mean low water.

Eng 56 2


Three #8 Wire Strands
Three #8 Wire Strands
Anchor Pile
10 feet

S, MO.

K.

Eng 56 2

APPENDIX 3.

OF CAPT. E. EVELETH WINSLOW, CORPS OF ENGINEERS, UPON OPERATIONS IN THE FIRST AND SECOND DISTRICTS.

UNITED STATES ENGINEER OFFICE,
Memphis, Tenn., May 20, 1900.

EL: I have the honor to submit the following report of operations in the First ond districts, improving Mississippi River, for the year ending April 30, 1900:
irst district extends from Cairo, Ill., to the foot of Island No. 40, a distance iles, and includes, in addition, the levee work on the right bank of the Mis- River above Cairo as far as Commerce, Mo., a distance by river of 35 miles. les the works of bank revetment at Columbus and Hickman, Ky., and at drid and Caruthersville, Mo.; the systematic improvement of Plum Point Tennessee and Arkansas; the Upper St. Francis Levee district, and part of the t. Francis Levee district from its initial point to the one hundred and thirty- ilepost.
econd district extends from the foot of Island No. 40 to the mouth of White distance of 175 miles; but for convenience the limit of jurisdiction over the n the left bank has been placed at the Coahoma-Bolivar County line (365 L.), evees on that bank below that line belonging to the Third district. Within nd district are included the bank-revetment works at Memphis, Tenn., and d Bend and Helena, Ark.; the improvement of Wolf River, Tennessee; the River and Upper Yazoo Levee districts, and the lower part of the Lower St. Levee district.

FIRST DISTRICT (Cairo to foot of Island No. 40, 220 miles).

bus, Ky. (21 miles below Cairo, L.).—In 1889 and 1890 some revetment work e here with funds provided by special appropriations. The object of the s to stop the caving of the river bank along the city front. The project for contemplated the construction of 5 spur dikes resting on sill mattresses. 2, 4, and 5 were completed and the sill mattress of Dike 3, work being by the exhaustion of the appropriation. This work protects about 2,200 et of bank, and has accomplished the object for which designed. It is still ondition. Some slight caving has occurred in recent years between the dikes w Dike 5, where the bank is unprotected, but no additional work is required t.
an, Ky. (36 miles below Cairo, L.).—The work at this locality is designed to further caving of the river bank above the city and along the city front, and ied on with funds provided by special appropriations. In 1889 a mattress of nd stone, 930 feet long, was placed along the bank in front of the city. In was supplemented by paving the bank above low water with riprap. This s been repaired at various times, and in 1894 was extended downstream a of 630 feet, making the total length of continuous revetment now in place t.
the high water of 1899 subsided it was noticed that a serious washout had ace in the upper part of the bank at about the middle of the work done in his washout was caused by concentrated surface drainage and was subse- enlarged by eddy action. As the further enlargement of this hole would the permanency of the existing bank revetment, the matter was reported to mission in June, 1899, and they allotted for repairs the sum of $6,000 from s made available by the sundry civil act of March 3, 1899. The project for pairs contemplated the construction of a crib dike founded on a sill mattress ne hole to stop the eddy action and the revetment of the banks of the hole ecessary to prevent further caving. This project was carried out, the work gun December 19 and being completed January 29. The field cost was . (Further details of the season's work will be found in the report of Engineer Rees.)
ank revetment at Hickman is now in good condition, and no additional work nplated.

New Madrid, Mo. (*71 miles below Cairo, R.*).—The work at this point has been done under special appropriations, and is for the purpose of preventing the caving of the river bank along the city front. This has been accomplished by the construction of a continuous revetment of the standard type, fascine river mattress 250 feet wide, and upper bank paving of riprap. Nine hundred feet of this revetment were built in 1893, 700 feet were added in 1894, 500 feet more in 1896, and 1,550 feet more in 1898.

In the sundry civil act of March 3, 1899, the sum of $40,000 was appropriated for the completion of the revetment work at this place. With this amount it was proposed to continue the revetment work, constructing it in the same manner as in the previous years, and to repair, where necessary, the work already in place. Work was begun November 26 and completed January 29. The revetment was extended downstream with work of the standard type, facsine river mattress 275 feet wide, and the riprap paving of the upper bank carried to the 25-foot stage. The river mattress constructed was 900 feet long, but it lapped by about 50 feet over the end of the previous work. Two small connecting mattresses were placed, one at Dry Bayou, at the head of the exising revetment, and the other at the mouth of Cypress Drain, below the work, both intended to prevent damage to the bank by surface drainage. Along that part of the city front used for landing purposes the bank paving formerly put in had been damaged by boats. This was removed, the bank graded and repaved, the paving being extended to the top of the bank. The field cost of the season's work was $25,192.05. (Further details will be found in the report of Assistant Engineer Rees.)

The total length of the New Madrid revetment is now about 4,500 feet and is all in good condition. This covers the entire city front and extends below it, and unless it is intended to continue this work as part of the systematic bank protection of the entire river no further extension is necessary.

Caruthersville, Mo. (*110 miles below Cario, R.*).—The work done here is intended to prevent the caving of the river bank along the city front and is carried on under special appropriations. The bank had been caving slowly for some years, but in 1897 this caving became quite rapid.

The sundry civil act of July 1, 1898, appropriated $20,000 to be used in protecting the bank at and near the town of Caruthersville, Mo. The appropriation being insufficient to protect the entire front of the town by a continuous revetment, it was proposed to construct with it four brush and pole crib dikes similar to those successfully used in Memphis Harbor, the dikes being placed about 450 feet apart, center to center, and having a standard mattress foundation 120 feet long by 250 feet wide. On account of various unavoidable delays it was late in the season before work could be begun, and the river rising soon afterwards caused a cessation of the work. All four sill mattresses had been built and sunk, but the crib work of only one of the dikes had been started, and work on that was stopped when it was only half completed.

The sundry civil act of March 3, 1899, appropriated $35,000 for rectifying the bank at and near Caruthersville. With the additional funds thus made available it was proposed to change to the continuous type of revetment work by joining the sill mattresses of the previous season with new mattresses, grading and paving the whole bank, and continuing this character of work downstream as far as the funds would permit. Work was begun August 26. Four river mattresses were constructed, three of them between and lapping on the sill mattresses of the previous season and one below the fourth of these sill mattresses. The bank was then graded and paved in the usual way. The old crib of the previous season had been sunk in an unfinished condition and had been seriously damaged by high water and had caused a violent eddy below it which had cut into the bank and had left this crib sticking out on a pronounced salient. The damaged crib was cut away above low water and the paving at and near the salient was carried to the top of the bank. No difficulties were met with except the slowness of the contractor in delivering stone. The field cost of this season's work was $32,931.19. (Further details will be found in the report of Assistant Engineer Nolty.)

There is now in place a standard continuous revetment 1,890 feet long, all in good condition, but should any funds be available in future it will be advisable to continue the paving to near the top of the bank. In one or two places the permanency of the revetment work is threatened by surface drains, but the city authorities are expected to take the necessary steps to prevent further damage from this cause.

Plum Point Reach (*147 to 186 miles below Cairo*).—The works of improvement in this reach have extended from above Daniels Point to near Craighead Point, Arkansas, a distance of about 20 miles (151–171), and have been carried on with allotments from appropriations for the general improvement of the river. The operations have been fully described in previous reports. In general terms, the work done has been the protection of caving banks by the construction of 63,000 linear

revetment now in place, the closure of Gold Dust Chute by means of pile
nd a brush and stone dam, and the closure of Osceola and Bullerton chutes by
f pile dikes, and the construction of a levee along the left bank of the river
ne the water to the river bed. The result of these works has been to give an
e in depth over the crossings in Plum Point Reach during extreme low-water

the funds made available by the sundry civil act of March 3, 1899, the Com-
allotted to this reach $60,000, which it was proposed to expend at the
ng points:

Point, repairs to revement	$15,000
rs Bend, revetment work	25,000
ust Dam, repairs	10,000
repairs and contingencies	10,000

dition to the above, the Commission in November made a further allotment of
or repairs to the revetment at Osceola and Bullerton bars. These allotments
balance of former allotments were expended in the following manner:

ls Point, Arkansas (152 R.).—The object of this revetment, 8,800 feet long at
is to maintain a fixed direction of approach to the bend next below. Work
un in 1889 by the revetment of 5,300 feet of bank. This was subsequently sub-
considerable damage, both ends being washed away, and had to be repaired
us times. In 1895 the existing revetment was extended upstream 4,850 feet.
a break occurred just below the junction of the new and old work and a large
e was constructed to protect this point. This crib was never completed and
rtially accomplished its object.

e beginning of this season the condition of the revetment was as follows: The
art of the work down to the dike, a distance of 5,200 feet, was all in good con-
the crib dike was in fair condition, but a tendency had been shown to cut
he point behind this dike. For the next 1,400 feet the upper bank work was
completely gone, the bank having receded into the form of pockets with sali-
ween them. The bank for the next 1,100 feet was in good condition. Next
me a deep pocket 700 feet long. Below this for 400 feet the subaqueous work
upper bank paving to the 14-foot stage was in good condition, but the remain-
he paving was gone, the river having cut in behind the revetment work.
g the season the following repairs were made: The 1896 dike was strength-
its shore end and a stone dike was built along the axis of the point of land
the high bank. Along the stretch of failing revetment two large crib dikes
ilt in the two deepest pockets to destroy the eddies, and all the salients were
ened by being heavily paved up to the top of the bank and by having con-
mattresses built along their flanks. The lower 700-foot pocket is not now
and at this point the only repairs made were the construction of a connect-
tress and the paving of the bank at the upper end of the pocket to prevent it
larging in this direction. The lower stretch of the work, where the revet-
disconnected with the shore, was repaired by the construction of a large
ching from the top of the existing revetment well into the bank. This was
brush and heavily paved, and was placed on a sill mattress to prevent scour
e overfall. The field cost of the work was $17,823.79. (Further details will
d in the report of Assistant Engineer Nolty.)

rt Bend, Tennessee (155–157, L.).—The revetment work in this bend begins at
Deer Chute and extends to the Gold Dust dikes, there being, however, an
ted interval of 3,800 feet. Two thousand six hundred and ninety-four feet
ress work were constructed in 1882 just below Forked Deer Chute. In 1892
as resumed, and was continued in 1893 and 1894, the revetment then con-
beginning 3,800 feet below the foot of the 1882 work and extending to the
distance of 16,540 feet. All of this work, except 6,800 feet at the lower end,
e old woven type of mattress; that length is revetted with the standard fas-
ttress 300 feet wide. The 1882 work and the interval below it are now cov-
a sand bar, which has grown until it laps over the head of the 1892 work.
the subsidence of the flood of 1898 it was found that five faults had devel-
this work, three in the upper bank work above the limit of paving and two
nction of the mattress work with the paving. During the season of 1898–99
est of these only had been repaired, when the rising river caused a cessation
. At the beginning of the present season these faults still existed and other
nes had developed. Most of these faults are due to the failure of the old-
vetment at the junction of the subaqueous mattresses with the paving. These
ere repaired by constructing connecting mattresses lapping over the breaks
repaving the bank. The other faults were at the top of the paving, and

across these small stone dikes were built to check the current. The field cost of this work was $16,379.37. (Further details will be found in the report of Assistant Engineer Nolty.)

Fletchers Bend, Arkansas (158–161, R.).—This bend has been caving for many years. Some 5,000 feet of revetment work was done here in 1884. This was of the old-style work and all of it has since been destroyed or has been covered by more recent construction. Work was resumed in 1888 and in this and the following year two long portions of bank were revetted. The upper portion began 2,500 feet below the head of the 1884 work and consisted of 3,000 feet of continuous revetment. The lower portion began 3,800 feet below the end of the upper portion and consisted of four sections, each 1,100 feet long, separated by gaps of 300, 400, and 500 feet. In 1891 the old work was repaired and the interval between the portions was closed by a continuous revetment. Other repairs were made from time to time, and in 1895, the gaps having shown a tendency to enlarge, stone groins were built at the ends of the existing sections of interrupted revetment. The end of the lowest section had been washed away and a large pocket had been cut into the bank by the resulting eddy. Across this pocket a large crib dike was built to break up this eddy. In 1896 another dike was constructed to break up the eddy in the largest gap. In addition, 2,600 feet of new revetment work was constructed below the 1895 dike. This extended the work to a total length of 17,700 feet from the head of the initial work in 1884.

Since 1896 the caving has attacked the bank actively at and above the head of the existing work, and much of it has been destroyed. To prevent or delay the further destruction of this work, there was constructed in 1898, at the head of the then existing work, a large crib dike. During the high water of 1899 a violent eddy was created immediately below this dike, causing the bank to cave into a large and deep pocket and destroying all that was left of the 1884 work.

To repair this a large fascine mattress was constructed, covering the floor of this pocket and lapping over the sill mattress of the crib above and the still intact river mattress below (1888 work). This pocket mattress was 767 feet long. The bank of this pocket was then graded and paved in the usual manner, and the paving of the bank below was then repaired where it had been injured by the violent eddy current. The dike itself had been damaged and partially undermined; so the part above water was removed and the point thus exposed was heavily paved to the top of the bank. The bank above the dike was caving badly, and to check this the work was extended upstream about 325 feet with the standard revetment. The field cost of this work was $37,938.12. (Further details will be found in the report of Assistant Engineer Nolty.)

The revetment of this bend now covers a distance of about 16,300 feet and is in fair condition. The bank in the bend above the work is still caving rapidly, and the existing revetment must be extended or else constantly repaired at its head to prevent its destruction.

Lower end of Osceola Bar (168, R.).—The revetment along the lower part of this bar was built in 1890 and 1891, and is of the old style of woven mattress. It is 5,500 feet long. The change in the low-water channel has caused this work to be very seriously attacked by the current at low water, and it is giving away just at the junction of the subaqueous and bank work. Another cause tending to the destruction of this revetment work is the soft, porous character of the bank and the formation back of it of lakes or ponds after temporary rises in the river. One of these faults, developing during the season's work, was entirely above the level of the river at the time, and was due to the oozing out of the soft material of the bank from the seepage of water from these lakes.

Two of these faults were repaired in 1898, but at the beginning of this season's work others had developed. These were repaired in the usual manner, by building connecting mattresses over the breaks and then repaving the bank. The field cost of these repairs was $9,299.57. (Further details will be found in the report of Assistant Engineer Nolty.)

During the work this season an examination was made, and the whole of this old-style work was found to be badly broken up at and below the low-water line, and should the river continue its severe attack upon it, this portion of the revetment will fail completely. Just after the completion of the repairs above mentioned another small fault occurred, but the rising of the river prevented its repair.

Gold Dust Dam (159, L.).—The works built in Gold Dust Chute had for their object the closure of this chute, thus confining the water at low stages to the main channel. In this they have been successful. These works have consisted of a series of pile dikes at the head of the chute built in 1882 to 1884; pile dikes at the lower end built in 1889 between Elmot Bar and Island 30, and Island 30 and the Tennessee shore, and Gold Dust Dam.

This structure runs from Elmot Bar to the Tennessee shore about a mile and three-quarters below Gold Dust Landing. It was built in 1893. It at once began to settle and repairs were made in the fall of 1894 and again in 1895. At the beginning of this season's work its condition was as follows: Near the Elmot end of the dam there was a depression about 100 feet long down to about 12 feet on the gauge (original height of dam was 16 feet). Then for 450 feet the dam was completely silted up and covered several feet deep with accumulated sand and gravel. Then for about a quarter of a mile the dam was visible and intact, though settled slightly below the original level. At a point about 1,900 feet from the Elmot end and 1,000 feet from the Tennessee shore there was a break in the dam 91 feet wide at the water edge and 18 feet deep. From this point to the Tennessee shore the dam was intact, but had settled somewhat. The shore line just below the Tennessee end of the dam had been cut into a pocket and indicated the tendency of an eddy to cut behind and around the end of the dam. Below the dam from the break to the Tennessee shore there was a pond of water, in one place as much as 60 feet deep. The repair work done was as follows: The break was closed by a large crib built on a sill mattress which lapped on the connecting mattress below the break and spread out in a fan shape above, so as to cover the bottom thoroughly. This crib was built in the shape of an arch to resist better the pressure that the water would bring against it. This crib and the dam near it were brought up to the original level, 16 feet on the gauge, by brush work and paved with stone. The depression in the Elmot end was treated in the same way. The pocket in the Tennessee shore below the dam was covered with a floor mattress to prevent deepening and the bank was covered with a light paving of brush and stone. The field cost of these repairs was $10,258.02. (Further details will be found in the report of Assistant Engineer Nolty.)

Before these repairs were quite completed the river rose slightly, filling up the pool above the dam and causing a head of water on the upper side of as much as 5 feet. Under this head the new crib in the gap was pushed somewhat out of line and settled nearly 3 feet. Subsequently the work was submerged, and at this date is still under water. It has been reported that just before the complete submergence of the dam a new break occurred, this time 400 feet toward the Elmot shore from the old gap. This seems to have occurred from the foundation of the dam being pushed completely out by the head of water, leaving the dam as a bridge, which of course rapidly broke up. The whole dam being still under water, no details of the amount of damage can be given.

Other works.—In addition to the above mentioned places in Plum Point Reach where work has been done this season the improvement has consisted of the following:

The closing of Osceola and Bullerton chutes by pile dikes, built in 1882 and 1883 and repaired since. These dikes have accomplished their purpose, and the old channel behind Osceola and Bullerton bars and the chutes leading to it are almost completely silted up and contain water only at high stages.

The revetment of the upper part of Osceola Bar, built in 1883 and 1895; 6,850 feet of this work are still in place and in good condition.

The revetment of Bullerton Bar, built in 1883 and repaired in 1893 and 1894; 9,100 feet of this work are in place and in good condition.

Pile dikes at Plum Point. These were built in 1883 and 1884 to narrow the river. and have accomplished their purpose, causing the growth of a large sand bar.

Levee.—This was built in 1887 from the old levee back of Ashport to Plum Point, a distance of 12 miles. The levee was broken in several places by the flood of 1897, and part of it near its lower end has caved into the river.

SECOND DISTRICT (foot of Island No. 40 to mouth of White River, 175 miles).

Hopefield Bend, Arkansas (227–230 miles below Cairo, R.).—The revetment in this bend, now about 16,200 feet long, extends from Mound City Landing to Hopefield Point, and was constructed from funds allotted by the Commission from appropriations for the general improvement of the river.

The object of this revetment is to prevent the further caving of this bend and the consequent growth of the opposite bank and the encroachment of the sand bar upon the wharf front of Memphis. Work was begun in 1882 and was continued, except when stopped by high water, until 1884, 9,600 feet of bank being revetted, of which, however, 1,500 feet at the lower end were destroyed before a further extension of the revetment was made. In 1887 this work was extended downstream 4,000 feet, the width of mattresses being increased from 140 feet, used in the previous work, to 200 feet. In 1888 the work was extended to the Point. When work was started it was hoped to hold the bank about in the position it occupied at that time, but the failure of appropriations at critical times prevented this, and before the revetment reached

Hopefield Point the bank there had receded by caving more than 3,000 feet. Repairs have been necessary from time to time both to the subaqueous work and, in 1897 and since, to the bank above the paving. All mattress work done prior to 1893 was of the old-style woven type, and as this had given signs of deterioration it was thought necessary, on account of the importance of holding this point, to cover it with the new standard fascine mattress. For this work the Commission allotted, from the funds made available by the sundry civil act of March 3, 1899, the sum of $60,000. Work was begun in August and completed in October. Three river mattresses of a total length of 3,350 feet were built and sunk over the previously existing woven mattresses. Several small connecting mattresses of the same fascine type were built where necessary along the inshore edge of the river mattresses. The bank paving was repaired at various places, and a small crib dike was built from the top of the paving to the top of the bank to assist those built in previous years in preventing the threatened washout at this place. Around the point at the extreme lower end of the work a small stone dike was built to stop the tendency of the eddy current to wash this point away from below. The total field cost of the work was $54,540.31. (Further details will be found in the report of Assistant Engineer Rees.)

Present condition.—The lower 6,000 feet of the revetment of this bend is all in good condition, the mattresses being of the fascine type built in 1893 and 1899. However, the river at places has shown a tendency to cut away the bank above the top of the paving, and it is believed to be desirable to extend the paving to the top of the bank. The remainder of the existing revetment, 10,200 feet, was built with the woven type of mattress work, but this portion of the bend is not now subject to a very severe attack by the current. This protection has proved sufficient, and it is not believed that any very extensive repairs are required. The bank around the point at the lower end of the work has shown a tendency to cave back slowly from eddy action, and it is thought that an extension of the revetment work is desirable at this point.

It is absolutely necessary for the existence of the present Memphis wharf front that Hopefield Point should not be allowed to recede farther.

Wolf River (230 miles below Cairo, L.).—This work is carried on by special appropriations, and its object is to keep the channel of this river navigable during the low-water season as far as the county bridge, about 2½ miles above the mouth of the river. The channel of this river for the lower 2,000 feet is through the Memphis sand bar.

The river and harbor act of June 3, 1896, made available for the improvement of this stream the sum of $35,000. The approved project provided for dredging and the removal of sunken logs, snags, and other obstructions. An attempt was made to have this work done by contract, but during the progress of the work so many unexpected difficulties presented themselves that justice to the contractor required the termination of the contract, which was done May, 1898, after about 30,000 cubic yards of material had been removed.

In July, 1898, a dipper dredge was purchased for use on this work and operations were subsequently carried on by hired labor. During the season of 1898–99 about 28,000 cubic yards were dredged and a large number of snags were removed.

During the season of 1899 some alterations were made to the dredge, and with it operations were resumed in August. No scows being available the material dredged was dumped on the banks. This method had previously been very successful, but this season the material was so soft that much of it soon slipped back into the channel. On the whole the operations were not successful, navigation being impeded for nearly three months. This was partially due to extremely unfavorable natural conditions. The Mississippi remained at a relatively high stage until late in August and then dropped with extreme rapidity, and during the season the discharge of Wolf River was so small as to be unable to assist the improvement by scouring. During the season 32,860 cubic yards of material were removed, at a field cost of less than 11 cents per yard. (Further details will be found in the report of Assistant Engineer Le Vasseur.)

At each high water of the Mississippi there will be a deposit of sediment in Wolf River, especially near its mouth, which deposit must be removed by dredging.

During the coming season it is intended to construct for future use on this work two dump scows, and with them it is expected that the channel can be kept open.

Memphis Harbor (230–232 miles below Cairo, L.).—The work at this point is the protection of about 14,800 linear feet of bank. It has been done by special appropriations, by allotments from the appropriations for the general improvement of the river, by funds raised by the citizens of Memphis, and by the bridge company.

This revetment for a distance of 7,700 feet was constructed by the United States in 1884 to 1887, beginning 1,220 feet above Wolf River and extending to below Beale street. Thence for 2,200 feet the bank is protected by a series of dikes built in 1886

by United States employees with funds raised by the citizens. These dikes have several times since been repaired by the United States. Thence for 3,640 feet the revetment was constructed by the United States in 1894, 1896, and 1898. This work laps on the bridge company's revetment of 1890, which extends a farther distance of 1,260 feet. All of this work is of the continuous type except the 2,200 feet of citizens' dikes. The paved levee of the city extends from Jefferson street (4,700 feet below the head of the revetment) to Beale street, a distance of about 2,800 feet.

No allotment or appropriation was made for this improvement during the past year, but there was a small balance of an old special appropriation remaining. With a part of this slight repairs were made to the bank protected by the above-mentioned dikes. At two places small connecting mattresses were built to stop the scour between the dikes that threatened to cut deep pockets at these places; two of the dikes were repaired by replacing part of the crib work and its stone covering, and a short section of the bank in one of the pockets was paved to keep the current from attacking a stratum of fine water-bearing sand there outcropping. The field cost of this work was $3,523.99. (Further details will be found in the report of Assistant Engineer Rees.)

The revetment work along the Memphis front is now in good condition, but the wharf front from Wolf River down to Monroe street is obstructed by a large sand bar that formed here as a result of the caving away of Hopefield Point. In its present condition the bar makes about half of the paved levee inaccessible to steamboats except at high stages. This bar, though increasing in height, is not extending downstream, and to prevent such an extension, which would be ruinous to the existing wharf front, it is essential that Hopefield Point be not allowed to recede farther.

Helena Harbor (306 miles below Cairo, R.)—The work at this point has been done under special appropriations and consists of the protection of the bank for a length of 4,900 feet, to prevent its erosion and the encroachment of the river upon the town. Part of this bank revetment is of the continuous type and the rest consists of a series of dikes.

The sundry civil act of March 3, 1899, appropriated $30,000 for improving harbor and rectifying the banks at Helena, and with this money work was begun October 4 and completed December 22. When work was begun in this harbor in 1889 there was constructed at the upper end of the revetment a mattress 613 feet long by 226 feet wide, unaccompanied by the usual upper bank paving, the bank here being of a very tough material. In the years that have since elapsed this bank has caved back slowly, leaving the mattress unconnected with the shore even at low water. Along this strip of bank there was built this year a standard fascine mattress touching the bank along the low-water line and lapping over the old mattress. From the downstream end of this old mattress the new mattress was made full width, 250 feet, and extended until it lapped on the sill mattress of the first dike below. The bank along this stretch was then graded and paved. In addition to the above work a considerable amount of repair work was done to the dikes, especially at and near the location of Dike 4. The field cost of the season's work was $18,198.86. (Further details will be found in the report of Assistant Engineer Rees.)

This season's work makes the revetment continuous from the head of the work at the elevator to Dike 1, a distance of 1,140 feet. Thence for 1,180 feet to Dike 4 the revetment consists of the dikes built in 1889 and repaired frequently since. Floor mattresses have been built in all the intervals except one, so that below water the work is continuous except for an interval of 230 feet. Below Dike 4 the work consists of the standard type of continuous revetment for a distance of 2,580 feet (built in 1896 and 1898) with the addition of crib dikes across a depression in the upper bank.

All of this revetment work is now in good condition, but it is probable that in the future the paving must be extended to the top of the bank and that further repairs will be required to the dikes.

GENERAL REMARKS UPON CHANNEL WORK DURING THE SEASON.

The conditions under which channel work has been prosecuted this season have, on the whole, been extremely favorable. Labor has been abundant and there has been no interference from epidemics or quarantine. The stage of the river has been exceedingly favorable. The water had fallen low enough to begin mattress work by the latter part of August, and after that it continued to fall, and from September 1 to December 15 the river was continuously below the 5-foot stage. Under these conditions mattress work could proceed rapidly and cheaply. However, though the stage of the river was favorable for mattress construction, it had one great disadvantage in that it seriously interfered with the delivery of stone in the first district. This stone came from quarries situated above Cairo, and the water was for a long time

so low in the Ohio and Upper Mississippi rivers as to stop barge navigation, thus causing serious delays in stone deliveries. On this account it became necessary to save all available stone for mattress sinking and to put off bank paving until later in the season. This tended to a considerable increase in the cost of the work, and I consider it would be economical in the future, whenever it is possible to estimate the locality where stone will be needed, to purchase this during high water and store it on the bank where it will be convenient to the work. This will require additional handling of the stone, but the cost of this will, I believe, be more than regained in the decreased price of the stone delivered during high water and the certainty of having it on hand when required.

LEVEES.

Upper St. Francis Levee district (35 miles above to 70 miles below Cairo, R.).—This district extends from Commerce, Mo., to New Madrid, Mo., a distance by river of about 105 miles. The length of levee line when completed will probably be about 85 miles. The area protected is the land between the river and Prairie Ridge, which is cut by the river at New Madrid. This area is about 700 square miles. This land, though generally low, is separated into sections by ridges, which are above all except the highest overflows. In addition to the above area a very large part of the Lower St. Francis Bottom is subject to overflow from this same water, as it can find its way through the low gap at the upper end of Prairie Ridge. The latter region is also subject to overflow by high water getting through the narrow gap between Cape Girardeau and Commerce Ridge, but a small State levee has been built across this gap. A levee has been built by local authorities from Commerce to the Iron Mountain Railroad, a mile above Birds Point, and is in good condition. From Birds Point southward a levee was started in 1896 by local authorities, but owing to financial difficulties work was soon stopped. This incomplete levee was seriously damaged by the flood of 1897. There is not at present any data in this office from which to calculate the amount of earth in the existing levee from Commerce to Birds Point, or the total yardage necessary to completely levee this district, but a survey is now being made by the local levee board which will, when completed, give this data. It is not, however, believed that more than 7,000,000 cubic yards of additional levee will be necessary to complete the levees of this district.

Out of the funds made available by the sundry civil act of March 3, 1899, the Commission allotted the sum of $20,000 for work at and below Birds Point. With this the work of repairing and completing the existing fragmentary levee was begun under contract dated July 15, 1899, at 12.99 cents per cubic yard. The levee as constructed begins at the Cotton Belt Railroad embankment at the southeast edge of the town of Birds Point, makes a loop around the large hole washed out in 1897, and thence follows the line of the old levee, all being completed to the standard Mississippi River Commission levee grade. Three miles and 2,950 feet were completed this season.

During the period from May 1, 1899, to April 30, 1900, there were constructed by the United States 135,544 cubic yards. During this period the United States expended the sum of $19,591.22, this including office expenses, superintendence, surveys, engineering, and contingencies. The average cost, including the above items, was 1445 cents per cubic yard.

The completion of this piece of levee by the United States leaves a break in the levee line of about 1 mile through the town of Birds Point, the State levee ending at the Iron Mountain Railroad, at the northwest edge of the town, and the new United States levee beginning at the Cotton Belt Railroad at the southeast edge. The embankment of this latter railroad is above all except the highest floods, and negotiations are now in progress between the local authorities and the railroads looking to the closing of this gap in the levee line.

Lower St. Francis Levee district (79 to 298 miles below Cairo, R.).—This district extends from the high lands, about 9 miles below New Madrid, to the mouth of the St. Francis River. Its length by river is 219 miles. The length by levee line when completed will probably be about 207 miles. The area that will be protected by the completed levee will be about 3,500 square miles.

The total length of levee already built is about 161 miles, divided into two sections by an unleveed interval of 36 miles. The upper section is 144 miles long, beginning 1 mile above Point Pleasant, Mo. (79 R.), and ending at the Choctaw Railroad embankment, across from Presidents Island (235 R.). The lower section is 17 miles long, beginning at Holtree Bayou, back of Council Bend (268 R.), and ending near Walnut Bend Landing, Arkansas (282 R.).

At the date of the last annual report one contract was in force, that of T. Mike, for enlargement work near Tyler, Mo. (125 R.). This contract was satisfactorily completed by July 1, 1899.

From the funds made available by the sundry civil act of March 3, 1899, the Commission allotted the sum of $123,500 for levee work in this district. This was used in work at the following points: New loop at Point Pleasant, Mo., milepost 1 (80 R.); new loop at Caruthersville, Mo., twenty-ninth mile (110 R.); new spurs at Rankins Mill, Missouri, milepost 16 (95 R.); repairs, enlargement, and topping below Point Pleasant, Mo., second and third miles (81 R.), and from near Gayoso, Mo., Station 29, mile 23, to near Caruthersville, Mo., Station 32 on mile 28 (106–109 R.); and from near Caruthersville, Mo., Station 48 on mile 29 to Cottonwood Point, Mo., milepost 41 (110–123 R.); and from near Arkansas-Missouri State line, milepost 47, to milepost 51 (128–131 R.); and near Long Lake, Station 14, mile 65, to Station 20, mile 66 (151 R.); and near Sans Souci, Ark., on miles 82 and 83 (167 R.); and in Nodena Bend from Station 39 on mile 93 to Station 27 on mile 96 (178 R.); and near Golden Lake, Ark., from Station 22 on mile 101 to Station 17 on mile 103 (189 R.). The average contract price of the above work was 14.87 cents per cubic yard. All the above levee work has been completed to an elevation about 2 feet below the established Mississippi River Commission levee grade.

In addition to the above work done by the United States, the St. Francis Levee board has repaired and enlarged the levee on miles 103, 104, 105, 106, and 109 and has constructed 33 miles of new levee; from back of Centennial Island near milepost 128 (207 R.) to the Choctaw Railroad back of Presidents Island, near milepost 151 (235 R.), a distance of 22 miles; and from Holtree Bayou back of Council Bend (268 R.) to the upper end of Walnut Bend levee (280 R.), a distance of 11 miles. They expended, for all purposes connected with the levee during this period, the sum of $606,522.07.

In addition to the above, the levee across Stancils Bayou, mile 15 (93 R.), where it had been cut in the summer of 1898, was repaired by the parties who cut it, under the persuasion of the United States Department of Justice.

During the period from May 1, 1899, to April 30, 1900, there were constructed as follows:

	Cubic yards.
By the United States	661,591
By the St. Francis levee board	3,651,680
Total	4,313,271

During the same period the United States expended the sum of $124,440.46. This includes office expenses, superintendence, surveys, engineering expenses, and contingencies. The average cost, including the above items, was 18.8 cents per cubic yard.

The following is a summary of the levees in this district:

	Cubic yards.
Constructed by United States and in place April 30, 1899	3,233,347
Added from May 1, 1899, to April 30, 1900	661,591
Total	3,894,938
Constructed by levee boards and citizens and in place April 30, 1899	4,176,561
Added from May 1, 1899, to April 30, 1900	3,651,680
Total	7,828,241
Levees in place April 30, 1900:	
Erected by the United States	3,894,938
Erected by local authorities	7,828,241
Total in place	11,723,179

The existing levees in this district are generally in good condition. The portion built previous to the 1897 flood has been greatly strengthened, and the new levees built since have been constructed to a height considerably above that flood line and with a substantial cross section. As stated above, the levee is divided into two sections by an unleveed interval of 36 miles. The lower stretch of levee is intact, but in the upper stretch there is a gap 600 feet long at milepost 1 on the loop back of the town of Point Pleasant (80 R.). This is owing to the failure of the local authorities to provide the necessary right of way. The United States had made a contract for the construction of this entire loop, but owing to the neglect of the levee board to purchase the right of way for this 600 feet, that length was not built.

To completely close in the Lower St. Francis Levee district and to finish the existing levees to the Commission's standard grade and cross section will require about 12,500,000 cubic yards, divided as follows:

To complete the upper section of existing levee, Point Pleasant to opposite Memphis (144 miles)	5,230,000
To close the gap between two sections (36 miles)	4,440,000
To complete lower section of existing levees (17 miles)	1,070,000
To extend levee to mouth of St. Francis River (10 miles)	1,760,000

This will probably cost about $2,000,000.

White River Levee district (306 to 385 miles below Cairo, R.).—The length of this district by river is 79 miles, and by the levee line 74 miles. The levee starts at the foot of Crowleys Ridge at the upper end of the city of Helena, and the terminus is at the end of the back line of the Laconia Circle levee, which doubles on itself and joins the main line at Laconia (373 R.). The United States has control of 64 miles of the levee, the remaining 10 miles of levee being maintained and controlled by the local boards, 8 of these miles consisting of the back line of the Laconia Circle, and the other 2 being in front of the city of Helena. The territory to be protected is a narrow strip of from 8 to 30 miles in width, lying between the Mississippi and White rivers, and having an area of about 910 square miles. Four breaks exist at present in this line, all made by the flood of 1897. The total length of existing breaks is about 10,000 feet, and all are situated within a distance of 6 miles near Modoc and Hugheys (335 to 341 R.).

At the date of the last annual report one contract was in force, that of Martin Jennings & Co., for work on this levee in Zenor Bend (362 R.). This contract was satisfactorily completed by December 31, 1899.

From the funds made available by the sundry civil act of March 3, 1899, the Commission allotted for levee work in this district the sum of $61,750. With this work was done as follows: Repairs, enlargement, topping, and banquet below Helena Ark., from Station 47, mile 2, to Station 20, mile 6 (306–310 R.); at Westover, Ark. near milepost 13 (320 R.); near Kangaroo Point, Ark., from Station 14, mile 15, to end of mile 16 (321 R.); near milepost 35 (342 R.); and on mile 40 (345 R.); and back of Zenor Bend, miles 44 and 45 (361 R.); and from Phillips-Desha County line Station 25, mile 50, to Station 13, mile 53 (365–368 R.). The average contract price of the above work was 17.4 cents per cubic yard.

During this period the local levee boards have done repair and enlargement work on the Helena City levee, miles 1 and 2; and on miles 6, 7, 8, and 9; on miles 37 and 39, and on miles 70, 71, 72, 73, and 74. They put up about 218,280 cubic yards of earth, and expended for all purposes about $54,300.

During the period from May 1, 1899, to April 30, 1900, there were constructed as follows:

	Cubic yards.
By the United States	210,214
By local levee boards and others	218,280
Total	428,494

The United States expended in this district for levee construction between May 1, 1899, and April 30, 1900, the sum of $51,573.01. This includes office expenses, superintendence, surveys, engineering expenses, and contingencies. The average cost per cubic yard, including the above items, was 24.53 cents.

The following is a summary of the levees in this district:

	Cubic yards.
Constructed by United States and in place April 30, 1899	5,531,732
Added from May 1, 1899, to April 30, 1900	210,214
Total	5,741,946
Constructed by levee boards and in place April 30, 1899	1,043,066
Added from May 1, 1899, to April 30, 1900	218,280
Total	1,261,346
Levees in place April 30, 1900:	
Erected by United States	5,741,946
Erected by local authorities	1,261,346
Total in place	7,003,292

On April 30, 1900, two contracts are still in force, one with W. N. Straub, for enlargement and repairs near Kangaroo Point, miles 15 and 16 (321 R.), and the other with E. B. Mantle, for enlargement and repair work in Zenor Bend, mile 45 (361 R.). It is expected that these contracts will be completed by November 1, 1900.

The levee in this district is generally low and weak; much of it is below the high water of 1897; much consists of an old levee of good cross section, but of insufficient height, upon which has been placed a topping with steep slopes and a narrow crown. There are at present, as stated above, four breaks in the system, with a total length of about 10,000 feet. To close these gaps and construct the levee to the commission's standard grade and cross section will require about 9,300,000 cubic yards. Besides this, the levee for about the 4 miles above Beiths Landing (367 R.) is in serious danger of caving into the river, and it will be advisable, instead of raising and enlarging the existing levee, to build a new levee back of the present one, which will increase the above estimate by 300,000 cubic yards, making a total yardage required to complete the present levee system of 9,600,000, which is estimated to cost about $1,728,000, including engineering expenses and other contingencies.

The above estimate does not include any work on the back levee of the Laconia Circle, which is considered a private levee and not part of the regular system.

Upper Yazoo Levee district (244 to 365 miles below Cairo, L.).—The length of this district by river is 121 miles, and the length of the levee line 124 miles. The territory protected by the levee is 3,281 square miles.

At the date of the last Annual Report one contract was in force, that with Aderholdt & Lowrance, for work on sections 81, 82 (332 L.), at 14.94 cents per cubic yard. This contract was satisfactorily completed by May 31, 1899.

From the funds made available by the sundry civil act of March 3, 1899, the commission allotted $123,500 for levee work in this district. With this the following work was done: Repairs, enlargement, topping and banquet above Friars Point, Miss., from milepost 65 to station 33 on mile 68 (315–318 R.), and from station 31 on mile 70 to station 26 on mile 76 (319–322 R.). The average contract price for the above work was 14.51 cents per cubic yard. This work leaving a balance of $24,000 from the above allotment, it is intended to use it in repairs and enlargement work on miles 30, 31, and 32, and proposals for this work will be opened May 12, 1900.

In addition to the above work done by the United States, the local levee board has repaired and enlarged about 13 miles of levee, being part of miles 6, 7, 32, 33, 34, 35, 61, 68, 69, 70, and 81 of the main levee and miles 18 and 19 of the Hushpuckana system. The contract cost of this work was $73,750.95.

They have made contracts for about 1,540,000 cubic yards of work to be done during the coming season.

During the period from May 1, 1899, to April 30, 1900, there were constructed as follows:

	Cubic yards.
By the United States	610,334
By the local levee board	422,617
Total	1,032,951

The United States expended in this district for levee construction during this same period the sum of $100,554.12. This includes office expenses, superintendence, surveys, engineering expenses, and contingencies. The average cost per cubic yard done, including the above items, was 16.47 cents.

The following is a summary of the levees in this district:

	Cubic yards.
Constructed by United States and in place April 30, 1899	4,899,516
Added from May 1, 1899, to April 30, 1900	610,334
Total	5,509,850
Constructed by levee board and in place April 30, 1899	10,861,765
Added from May 1, 1899, to April 30, 1900	422,617
Total	11,284,382
Levees in place April 30, 1900:	
Erected by United States	5,509,850
Erected by local authorities	11,284,382
Total in place	16,794,232

The levees of this district are generally in a very good condition, and at no point is there any immediate danger from caving bank. According to the recent surveys the estimated amount of earth required to raise and enlarge this levee line to the standard grade and cross section adopted by the commission is approximately 10,300,000 cubic yards; but of this amount the levee board has arranged to do about 1,540,000 cubic yards and the United States 160,000 cubic yards, leaving 8,600,000 cubic yards still to be provided for. The average cost of this work will probably be about 16 cents per cubic yard.

GENERAL REMARKS ON LEVEE WORK IN ALL THESE LEVEE DISTRICTS.

The levee work in these districts this season progressed under unusually favorable weather conditions, and was not greatly interfered with by epidemics and quarantines, though in some localities the existence of smallpox caused some delays. As a result all contracts have been completed which were to have been finished this season. On account of the large amount of earth work undertaken in the valley, both on railroads and levees, the price has been somewhat higher than in the last few years; in fact it was found difficult to let at all some of the contracts for work in the White River district, which was unfavorably situated. Two attempts were made in July and in August, but the prices bid being unsatisfactory, the proposals were rejected. Finally, in October contracts were made for this work, but with the agreement that only half of it was to be completed during the season, and the remainder during the coming summer.

A map composed of four sheets accompanies this report, and shows the existing levees in these districts and the portions where work has been done during the season.

OVERFLOW FROM HIGH WATER.

The high water of 1900 did not reach a stage high enough to overflow the banks of the river, and reached the levee only in the lowest places by backing up in sloughs and chutes.

SURVEYS, GAUGES, AND OBSERVATIONS.

During the time covered by this report the following examinations and surveys have been made:

General low-water survey of Plum Point Reach from head of Island 26 (147 L.) to Craighead Point (172 R.).

General low-water survey of Memphis Reach from head of Island 40 (213 L.) to the Memphis railroad bridge (232 L.).

Hydrographic survey of the river at Hickman, Ky. (36 L.).

Hydrographic survey of the river at New Madrid, Mo. (71 R.).

Hydrographic survey of the river at Caruthersville, Mo. (110 R.).

Hydrographic survey of the river at Daniels Point, Arkansas (152 R.).

Hydrographic survey of the river at Ashport Bend, Tennessee (154–157 L.).

Hydrographic survey of the river at Fletchers Bend, Arkansas (159 R.).

Hydrographic survey of the river at Osceola and Bullerton bars, Arkansas (166 R.).

Hydrographic survey of the river at Hopefield Bend, Arkansas (227–230 R.).

Hydrographic survey of the river at Helena, Ark. (306 R.).

Detailed survey of Gold Dust Dam and Chute, Tennessee (160 L.).

Detailed survey of dikes in Memphis Harbor (231 L.).

Examination of Wolf River before dredging (230 L.).

Examination of Wolf River after dredging.

Reconnaissance of Wolf River above the Second Street Bridge, with reference to a plan for improving this river by a flush dam.

Survey of caving bank at Birds Point, Missouri (0 R.).

Survey of new levee below Birds Point, Missouri, Upper St. Francis Levee district (0–5 R.).

Survey for levee loop at Point Pleasant, Mo. (80 R.).

General survey of Lower St. Francis Levee district from milepost 100 to milepost 127 (portion built by levee board during season of 1898–99) (188–208 R.).

General survey of Lower St. Francis Levee district from milepost 127 to milepost 151 (portion built by levee board during season of 1899–1900 (208–235 R.).

Reconnaissance Lower St. Francis district for proposed extension of levee from milepost 151 to Walnut Bend Levee (235–280 R.).

General survey of Upper Yazoo Levee district (244–365 L.).

Survey of railroad embankments opposite Memphis, Tenn., between the river and the line of new St. Francis Levee (231 R.).

Minor examinations and surveys were made from time to time during the season, at the various points where active operations were in progress.

PLANT.

From the funds made available by the sundry civil act of March 3, 1899, the commission allotted the sum of $25,000 for care of and repairs to plant in the First and Second districts.

Of the repairs made to plant the most important are as follows:

Steamer Titan.—In the last annual report this boat was mentioned as on the ways at St. Louis being repaired by contract. The contractor being unable, owing to financial difficulties, to complete these repairs, the United States assumed charge and completed them. The boat went into service at Plum Point Reach on October 28.

Steamer Chisca.—This boat while in service in October ran upon a sunken obstacle and was slightly damaged. These damages were promptly repaired and the boat continued in service.

Steamer Itasca.—The pilot house of this boat was destroyed by a collision. A new one was built.

Floating dock.—This was purposely floated on shore at Memphis during the high water of 1899. After the flood subsided, the sides and false bottom were entirely removed and replaced. Other repairs were made to the dock, and it was launched May 18 and put at once into service in the repairs to the other items of floating plant.

Dredge Wolf.—The alterations of this dredge referred to in the last Annual Report were completed.

In addition to the above most of the items of floating plant were repaired to a greater or less extent. The cost of these repairs was $36,371.71 and the cost of caring for plant $18,889.17. (Details will be found in the report of Assistant Engineer Nolty.)

The plant pertaining to these districts is now stored near Memphis, the floating property being moored to the bank a short distance below the bridge. Most of this is in a fair condition, but many of the articles have, from deterioration and use, reached a condition were extensive repairs are necessary, and some are no longer reparable and will be held for inspection and condemnation.

MODELS FOR THE PARIS EXPOSITION.

In accordance with the orders of the Commission there was prepared, under direction of this office, a set of models for the Paris Exposition to illustrate the operations in these districts of the Mississippi River improvement.

These models were as follows:

Model of typical section of improved bank, scale 1 to 50. This model illustrates a section of improved bank showing the standard revetment, the bank paving, and the fascine mattress with its ballast, and the levee with its banquette, berm, and borrow pit. The size of this model complete is 16 by 4.5 by 3.5 feet.

Model showing hydraulic grader at work, scale 1 to 50. This model illustrates a hydraulic grader at work grading a bank. The subaqueous fascine mattress is shown in place. The size of model is 5.4 by 4.2 by 3 feet.

Model showing the construction of a fascine mattress, scale 1 to 100. This model illustrates the mattress plant at work. It shows the mooring barges and their shore fastenings, the mattress barges with a portion of the mattress constructed, the loaded brush and stone barges, and a quarterboat. It shows the poles placed on part of the mattress and the ballasting in operation. The size of this model complete is 10.4 by 4.6 by 2.5 feet. There accompanied this a pamphlet giving a detailed description of the method of constructing the fascine mattress, and also full-size specimens of the clip, clamp, cable, and wire strand.

These models, together with one of the experimental dike work prepared under direction of the secretary, were shipped from Memphis March 3, 1900.

Accompanying this report and forming part of it are the following papers and drawings:

Report of Assistant Engineer Nolty on operations at Caruthersville and Plum Point Reach.

Report of Assistant Engineer Rees on operations at other points.

Report of Assistant Engineer Le Vasseur on operations on the improvement of Wolf River.

Report of Assistant Engineer Nolty on repairs to plant.

Map of Hickman Harbor.
Map of New Madrid Front.
Map of Caruthersville, Mo.
Map of Plum Point Reach.
Map of Memphis and vicinity.
Map of Helena Front.
Map showing existing levees, first and second districts (4 sheets).
Abstracts of proposals.
List of civilian engineers employed from May 1, 1899, to April 30, 1900.
Financial statement.
Respectfully submitted.

E. EVELETH WINSLOW,
Captain of Engineers.

Col. G. L. GILLESPIE,
Corps of Engineers, U. S. A., President Mississippi River Commission.

REPORT OF MR. AUG. J. NOLTY, ASSISTANT ENGINEER, ON CONSTRUCTION WORK IN FIRST DISTRICT DURING SEASON OF 1899–1900.

MEMPHIS, TENN., *April 30, 1900.*

CAPTAIN: I have the honor to submit my annual report of operations of the construction parties at Caruthersville, Mo., and Plum Point Reach, Tennessee and Arkansas, for the season 1899–1900.

CARUTHERSVILLE, MO.

The work to be done here was the protection against erosion of the town front, the extent of the work to be limited by the amount of the allotment. The original project contemplated the construction of four brush and stone spurs founded upon sill mattresses of proper dimensions. Part of this work was done during the season of 1898, but owing to the early advent of high water the project was not completed. At the time of suspension of work four sill mattresses had been placed and the substructure of the downstream spur lowered to the bottom. The latter, however, was badly displaced while being sunk, due to the large accumulation of drift and the very strong current.

Before work was resumed this season the project was changed to one calling for a continuous revetment of the standard type, the four sill mattresses already in place to form part of this revetment.

Work was begun on August 26, and on September 1 the first river mattress was started. This was so placed that when sunk it would overlap the lower edge of the sill mattress above and the upper edge of the one below. All subsequent mattresses were similarly placed, so that when all the mattresses were down they would form a continuous revetment.

Four main and two connecting mattresses were placed. The former were of the following dimensions, viz: No. 1, 225 by 386 feet; No. 2, 225 by 365 feet; No. 3, 220 by 368 feet; No. 4, 255 by 400 feet. The connecting mattresses were 32 by 177 feet and 38 by 40 feet.

After the mattress work had been placed the bank was graded to the usual slope of 1 on 3 and then paved up to the 18-foot contour, except at the false point formed by the crib sunk the previous year. The gradual recession of the bank above and below this crib had left this point very salient and had created a strong and destructive eddy below. To eliminate as much as possible the cause of this eddy, all of the crib above low water was removed, and after the removal the point was graded off, the object being to straighten out the bank line. Here the paving, in order to guard against surface scour, was carried up to the top of the slope, gradually tapering down on each side to meet the 18-foot contour.

No difficulties of construction were encountered during the progress of the work, but much delay was caused by scarcity of brush in the early stages and by lack of stone later on. The inadequate brush supply was caused by shortage in barges. As soon as this was remedied the supply of brush was always up to the demands of the work. The shortage in the stone supply lasted throughout the work and added materially to the cost of the latter. In several instances the sinking of mattresses had to be delayed, pending the arrival of stone. No one section of the paving could be completed to the required height, for when a tow of stone was received it had to be used in paving a narrow strip of bank, in order to keep the work ahead of any possible rise. This entailed a great deal of unnecessary shifting of barges and run-plank.

On October 25 all brush work had been completed, and all the plant, except grader No. 2, was moved to Plum Point Reach. One master laborer was left in charge to

employ local labor to complete the paving whenever stone arrived. The grader was left here to complete the grading—which was done by November 13—when it was moved to Plum Point Reach. Work was finally completed on December 23. From November 26 to December 23 the force worked only eleven days, stone coming in only at long intervals and in small lots.

As completed, the work begins 320 feet above Ward avenue and runs downstream a total distance of 1,890 feet. As before stated, the paving runs only up to the 18-foot stage. Lack of funds prevented its being carried higher; thus rather more bank is left unprotected against erosion than is desirable, but it is not believed that anything more serious than some chipping back along the upper plane of the riprapping will take place for one season at least.

All buildings that were situated within the ground required for the work were moved back without cost to the United States.

Three hundred and twenty linear feet of the mattress work now in place is to be credited to the work done in 1898. This work originally aggregated 480 feet, but the laps of the new over the old mattresses have reduced this to 320 feet. None of the paving of 1898 was saved, as the elevation of the old slopes was considerably above the new one. Hence the stone was removed and the old slopes regraded.

The steamer *L. E. Patton*, of the port of Memphis, Tenn., was under charter on this work from September 18 to October 27—a period of forty days—at $25 per day, the United States furnishing the crew and all supplies.

Should any funds be available in the future, it is urged that the riprapping of the bank be carried up to at least the 25-foot contour. Some provision to take care of the storm water should also be made. At present this water flows in a concentrated volume over the slope at two different places, and threatens the paving at those points. Two paved gutters were built here, from the top of the bank down, but these have been more or less undermined and partially destroyed. It appears to me that this is a matter for the local authorities to attend to.

The following is a summary of the work done during the season:

River mattresses, total area, 3,519.35 squares, or 39,104 square yards.
Connecting mats, total area, 71.84 squares, or 796 square yards.
Grading bank, 1,890 linear feet, or 46,761 cubic yards.
Paving bank, 1,890 linear feet, or 8,544 square yards.
The details of cost are as follows:

River mattress.

Labor, including superintendence and subsistence	$8,768.11
Brush, 5,186 cords	4,771.03
Poles, 147.28 cords	206.19
Poles, hard wood, 54 cords	21.60
Piling, 245 feet	16.17
Stone, 2,661.34 cubic yards	3,832.33
Wire strand, 35,470 pounds	1,706.10
Wire, galvanized, 9,240 pounds	234.73
Wire, silicon bronze, 570 pounds	76.95
Clips, 3,266	269.62
Staples, 290.5 pounds	9.27
Lumber, 4,710 feet B. M.	72.00
Towing	3,560.01
Total	23,544.11

River mattress constructed, 3,519 squares, or 39,100 square yards. Cost in place, $6.690 per square, or $0.602 per square yard.

Connecting mattress.

Labor, including superintendence and subsistence	$173.54
Brush, 140 cords	128.80
Stone, 199.6 cubic yards	287.43
Wire strand, 867 pounds	43.10
Wire, galvanized, 195 pounds	4.90
Clips, 84	6.93
Staples, 9.5 pounds	.30
Total	645.00

Connecting mattress constructed, 71.84 squares, or 798 square yards. Cost in place, $8.980 per square, or $0.808 per square yard.

Bank revetment.

Labor, including superintendence and subsistence	$2,689.62
Stone, 2,567.82 cubic yards	3,697.67
Coal (grading)	246.03
Miscellaneous materials	101.11
Towing	2,007.64
Total	8,742.07

Amount of bank paved, 8,544 square yards. Cost in place, $1.023 per square yard.

Towing.

Labor, including subsistencee	$2,823.08
Coal	1,744.57
Charter of steamboat (*L. E. Patton*)	1,000.00
Total	5,567.65

This has been charged into the work above described.

Summary of work done, with cost.

River mattress, 1,519 lineal feet, 39,100 square yards	$23,544.11
Connecting mattress, 798 square yards	645.00
Bank revetment, 8,544 square yards	8,742.07
Total cost of work in field	32,931.18

Length of revetment completed, 1,890 feet. Of this work, part of the subaqueous mattress was completed last season, at a cost of $12,237.26. Including this, the cost of the improved bank is $45,168.45, or $23.891 per lineal foot.

PLUM POINT REACH.

Daniels Point, Arkansas.—The work to be done here was the repair of the lower half of the revetment in this bend. In 1896 a large spur dike was placed at the point where the 1895 work joins that of 1889. This spur was designed to check any further enlargement of a large pocket that had formed during the preceding high water. Owing to interruption from high water this spur was never completed to the contemplated length and height. Instead of running out 240 feet from the zero line, it extended out only 111 feet. It was intended to complete the spur at some other time, when more favorable conditions existed. This, however, was never done. During the high water of 1898 and 1899 this pocket enlarged somewhat and two others formed below. At the lower end of the revetment the river also cut behind the work, forming a considerable cut between it and the bank. The works designed for the repair of these faults were to consist of two spurs in the pockets, one brush and stone dike across the cut, repairs to the shore end of the 1895 spur, and the revetting of the natural points between the pockets. Three pockets had been formed, the upstream one being the largest, while the downstream one was the smallest. In fact, the latter was so small and showed so little evidence of recent caving that it was not considered necessary to do anything more than to simply hold the points at each extremity.

Spur No. 1, located in the largest pocket, consisted of three tiers or cribs of the following dimensions, viz: Bottom, 280 feet long, 30 feet wide, 8 feet high; middle, 280 feet long, 20 feet wide, 8 feet high; upper, 285 feet long, 10 feet wide, 6 feet high. The middle and top cribs are stepped back from the outer end of the bottom one 25 feet and 60 feet, respectively. The total length of the spur, measuring from the shore end of the upper to the outer end of the bottom crib, is 333 feet. The whole spur was built in one piece, stone being placed from time to time in the pockets built in for that purpose, so as to gradually lower the structure to a convenient working level. The spur rests upon a fascine sill mattress 120 feet wide at the shore end, 160 feet at the outer, and 256 feet long, measuring from the low-water line out. Each tier is stepped into the bank 25 feet, and about 40 feet width of bank on each side of the shore end is heavily riprapped from the low-water line up.

Spur No. 2 is composed of only two tiers. The bottom one is 175 feet long by 24 feet wide and 8 feet high; the top one is 185 feet long, 10 feet wide, and 8 feet high.

Its total length from extreme shore end to outer one is 195 feet. Like No. 1, it is built in one piece. No sill mattress was considered necessary here.

Dike No. 3 was built on dry bottom. It is 185 feet long, has 35 feet base, 10 feet crown, and of an average height of 7.85 feet. Both face and back are battered about 1 on 1¼. The fascine mattress upon which it rests was built on the dry bottom and is 100 feet square. The bank end was treated like those of the other spurs, while its outer end rests against the old work.

Some damage had been done by previous high waters to the shore end of the spur placed in 1896, both on the upstream and the downstream side, so much so that only a narrow ridge of bank was left where the spur joined the bank. To prevent cutting through here and consequent isolation of the spur, brush and stone reinforcements were built on each side. The bank adjacent to this work, as well as the top, was then heavily riprapped, and, in addition, a small stone dam was built across the top to check the force of the current. One connecting mattress was also placed at the foot of the slope, on the downstream side, where the spur had been partially undermined by erosion.

The natural points, four in number, forming the extremities of the pockets, were graded off to an easy slope and heavily paved up to the top. To prevent scour at their below-water extremities these ends were lapped over with connecting mattresses.

Work was begun here on October 26 and completed on January 8. From December 5 to completion there was maintained here only a very small force, under one master laborer, to complete the stone work, which was delayed by the failure of the contractor to make prompt deliveries.

The following is a summary of work done:

Two sill mattresses, total area, 453.28 squares, or 5,036 square yards.

Seven connecting mattresses, total area, 438.34 squares, or 4,870 square yards.

Dike work, 215,097 cubic feet.

Grading and paving bank, 3,575 square yards.

The details of cost are as follows:

Spur dikes.

Labor, including superintendence and subsistence	$3,480.43
Brush, 1,368.68 cords	1,259.19
Poles, 128 cords	179.11
Stone, 971.05 cubic yards	1,413.86
Wire, galvanized, 7,924 pounds	254.84
Wire strand, 8,870 pounds	345.05
Staples, 639 pounds	22.67
Spikes and nails, 1,016 pounds	34.54
Miscellaneous materials	27.90
Towing	1,450.20
Total	8,467.79

Dike work built, 215,097 cubic feet. Cost in place, $0.0394 per cubic foot.

Sill and connecting mattresses.

Labor, including superintendence and subsistence	$2,033.99
Brush, 1,291.62 cords	1,188.29
Poles, 35.66 cords	49.93
Stone, 990.31 cubic yards	1,441.94
Wire, galvanized, 460 pounds	14.80
Wire strand, 13,905 pounds	540.92
Staples, 161 pounds	5.69
Clips, 689	54.33
Miscellaneous materials	16.51
Towing	1,040.18
Total	6,386.58

Mattress work constructed, 892 squares, or 9,907 square yards. Cost in place, $7.16 per square, or $0.645 per square yard.

Grading and paving.

Labor, including superintendence and subsistence	$1,560.6
Stone, 562.65 cubic yards	819.2
Coal, 755 bushels	16.0
Miscellaneous materials	46.3
Towing	527.9
Total	2,969.2

Amount of bank paved, 3,575 square yards. Cost in place, $0.83 per square yard.

Summary of work done, with cost.

Dike work, 215,097 cubic feet	$8,467.9
Mattress work, 9,907 square yards	6,386.8
Grading and paving, 3,575 square yards	2,969.2
Total cost of work in the field	17,823.9

Ashport Bend, Tennessee.—The revetment of this bend was completed in 1894, and it remained intact until the flood of 1898, after the subsidence of which it was found that the work had sustained three faults, two of them forming new pockets and one being a considerable enlargement upstream of a pocket formed by the high water of 1894, and subsequently repaired with a floor mattress and riprapping up to about the 6-foot stage. The flood of 1897, in gapping the Ashport-Plum Point Levee, had reopened two old sloughs that had been closed by this levee and this caused a cutting down to the upper plane of the paving of the parts of the bank in front of these sloughs, without, however, damaging the work itself.

The project for the season's work included the repair of the three faults and any other that the declining water might expose, and also the repair of the two washouts by means of two brush and stone cribs or dikes thrown across them. Later on it was found that these two structures would not be required, as a heavy growth of cottonwoods had sprouted across the entire width of the washout, and these in a short time would form an effectual barrier against any further enlargement.

In January, 1899, some construction plant became available from other works and an attempt was made to repair the faults before the close of the working season. Work was begun on a high and rising river, but had to be suspended after two days' work, owing to high stage of river and interference from drift. A piece of mattress that had already been constructed was launched and sunk in place.

Work was resumed September 7 and continued until October 30, when it was temporarily suspended owing to lack of stone. On November 14, there being a small surplus of stone, repairs were resumed with a small force and continued intermittently, as stone could be spared from other work, until December 6, when the party was moved up to Daniels Point, returning here on January 9 and finally completing the project on the following day. On December 6 the party heretofore working at Daniels Point stopped at this place while en route to Osceola Bar and placed one connecting mattress and otherwise repaired a newly developed fault. This required one and a half days' work of the party. The mattress placed measured 60 feet in width and 165 feet in length.

The repairs in general consisted in laying floor mattresses in the pockets, connecting mattresses at places where there was simply a separation of the old mattresses and the shore work, regrading and repaving the bank from the low-water line up to about the 24-foot stage, and putting in one small brush and stone crib across a washout just above the upper limit of the paving. The floor mattresses were so constructed that the shore edges lay up on the dry bank, while their outer edges lay well over the old river mattresses, making a good lap over these. It had been previously ascertained that the old mattress work was still intact, it having simply dropped down by being undermined from the inside. The false points forming the divide between the pockets were nicely graded off and then heavily riprapped to top of the bank.

The initial cause of all the damage was the separation of the subaqueous work from the bank work by reason of the settling of the former, thus leaving a zone of bare bank exposed to the erosive action of the current. All work damaged was of the old woven mattress type.

During the progress of the repairs in the pockets, and as the river declined, another fault, consisting of a rupture of the revetment along the low-water contour and extending longitudinally about 600 feet, was discovered. Also another similar fault

150 feet long. Both of these faults showed the paving considerably shattered for about 8 feet above the zero line, and the mattress work had either settled or slid down from 10 feet to 15 feet below that line.

Altogether the repairs required the placing of 1,805 squares of mattress, 1,890 cubic feet of crib, 12,933 cubic yards of grading, and 8,343 square yards of paving.

The following is a summary of work done:

Nine connecting mattresses, total area, 1,805.3 squares, or 20,060 square yards.
Dike work, 1,890 cubic feet.
Grading bank, 12,933 cubic yards.
Paving bank, 8,343 square yards.
The details of cost are as follows:

Connecting mattress.

Labor, including superintendence and subsistence	$3,566.67
Brush, 3,259 cords	2,998.28
Stone, 1,361.5 cubic yards	1,989.88
Wire, galvanized, 4,659 pounds	150.01
Wire strand, 14,546 pounds	820.66
Staples, 140 pounds	4.45
Clips, 973	76.86
Towing	1,531.68
Total	11,138.49

Connecting mattress constructed, 1,805.3 squares, or 20,060 square yards. Cost in place, $6.17 per square, or $0.55 per square yard.

Crib dike.

Labor, including superintendence and subsistence	$40.84
Brush, 24 cords	22.08
Poles, 3 cords	4.20
Wire strand, 1,218 pounds	68.75
Staples, 6 pounds	.20
Stone, 12 cubic yards	17.53
Towing	18.94
Total	172.54

Dike work built, 1,890 cubic feet. Cost in place, $0.091 per cubic foot.

Grading and paving.

Labor, including superintendence and subsistence	$3,319.46
Stone, 764 cubic yards	1,116.83
Coal, 343 bushels	43.90
Towing	588.05
Total	5,068.24

Bank paved, 8,343 square yards. Cost in place, $0.607 per square yard.

Summary of work done, with cost.

Connecting mattress, 20,060 square yards	$11,138.49
Crib dike, 1,890 cubic feet	172.54
Grading and paving, 8,343 square yards	5,068.24
Total cost of work in the field	16,379.27

Fletchers Bend, Arkansas.—In 1898 repairs were made to the work at the upper end of the revetment of this bend, constructed in 1883–84. The repairs consisted in the placing of a large spur, founded upon a fascine sill mattress, and the grading and paving of 150 linear feet of the bank against which the spur abutted. The work was located just below what was then the head of the revetment, and was placed here in the hope that it might arrest any further disintegration of the latter, which had been going on for years. It was not expected to save much, if any, of the older work, as that was already badly broken up, but rather to prevent the attack upon the more modern work below.

After the subsidence of the high water of 1899 it was found that, while the spur itself remained entirely uninjured in place, so far from arresting any further damage

to the work below, it had only accelerated the destruction by the creation of a violent eddy, which had torn away what had still remained of the old work. A long and deep pocket had formed, while above the bank had caved back considerably, thus leaving the spur and the bank against which it abutted in the form of a very bold and acute salient, which created a very ugly piece of water, full of whirls and eddies.

The cave in had taken away all that remained of the old work at the time the spur was built, and the caving had worked down to the head of the 1889 work.

The plan adopted for the repairs was to build standard revetment from the spur down, beginning as close to the latter as possible, and carrying the work down far enough to cover any damage that the modern work might have sustained. It was afterwards ascertained that this amounted to but little, and such as it was was altogether from the low-water plane up. So much of the spur as was above water was to be removed, the bank line to be straightened as much as possible by grading off the points, and then to revet as much of the bank above the spur as the funds remaining would permit.

Work was begun on September 28, and at first consisted in the clearing of the bank for 90 feet back from the edge of all standing timber and accumulated débris and removing whatever stone there might remain. Some snags were also removed by the steamboats; the small ones by the *Itasca*, the larger ones by the large boat. The bank was heavily timbered, and the heavy stumps afterwards retarded the progress of the graders considerably.

Mattress No. 1 was begun October 19. Its construction was rendered somewhat difficult by the peculiar shape of the shore line, which was somewhat of the shape of an elongated S, and also by the strong reverse current, which made launching difficult. Progress of mattress construction was somewhat slow, as the scant supply of brush and stone prevented the working of a full force. This mattress was sunk November 7, there not being a sufficient supply of stone on hand prior to that date. Owing to the prevalence of a strong eddy, the operation of sinking required four hours, and much more than the usual quantity of stone was required. For the same reason cables had to be run from the downstream edge of the mattress to anchorages below, in order to prevent the mattress from "crawling" upstream while being sunk.

Although this mattress was fitted as close as practicable into the pocket, some of the minor indentations in the shore line were so deep that three connecting mattresses were afterwards required in order to make the proper connection. One connecting mattress was also required to cover some slight damage at the foot of the main mattress.

Mattress No. 1 is 767 feet long by 265 feet wide.

It was found that of the funds allotted for the repairs there was enough remaining to permit the construction of about 350 linear feet of revetment above the spur; hence Mattress No. 2 was constructed. This was begun November 10. Owing to the projection of the spur far beyond the shore line, the mattress, after attaining a length of 328 feet, had to be launched and the mattress plant moved outstream 70 feet in order to permit of the plant passing the projecting point. Another piece of mattress 195 feet wide and 115 feet long was then woven and securely sewed and tied onto the mattress previously launched. This mattress was then 328 feet long along shore and 423 feet long on the outer edge. A connecting mattress was then placed to cover the space next above the spur not covered by the main mattress. Another small connecting mattress was required to cover a small indentation near the middle of the work.

Grading of the bank was begun as soon as the grader could get to the bank. Grader No. 40 began work November 1, and continued until the 10th, when the breaking of a piston head in the steam cylinder of one of the main pumps necessitated its withdrawal for repairs. These were not completed until the 24th. Grader No. 2 began work November 17. The bank was graded up to the 24-foot stage, a 6 to 7 foot bluff being left standing, except that at the point against which the spur abutted and at the point at lower end of pocket the grade was carried to the top of bank. As much of the brush work of the spur as was above the water surface was removed, and in grading care was had to straighten out the bank line as much as practicable.

The paving was carried up to the 20-foot plane, except at the above two points, where it was brought up to the top, thence curving down to meet the lower paving. The work of paving was frequently interrupted by want of stone, the force being idle for days at a time. To supplement the supply received from the contractor, considerable stone was gathered from the upper 10 feet of the work below, where the paving had been uniformly carried up to the crest of the slope, and some was saved from the destroyed work of 1884. About 500 cubic yards were thus obtained, and in addition, 200 cubic yards of spalls were taken from an old storage pile near the head of Section B.

The following is a summary of work done:
Two river mattresses, total area, 3,099.55 squares, or 34,440 square yards.
Six connecting mattresses, total area 494.22 squares, or 5,491 square yards.
Grading bank, 46,062 cubic yards.
Paving bank, 11,898.5 square yards.
Loading stone from bank onto barges, 700 cubic yards.
Clearing bank, 2.2 acres.
Snags removed, 11.
The details of cost are as follows:

River mattress.

Labor, including superintendence and subsistence	$6,933.06
Brush, 4,650.41 cords	4,278.38
Poles, 90.21 cords	126.30
Wire strand, 26,775 pounds	1,508.31
Wire, galvanized, 6,173 pounds	198.83
Staples, 408 pounds	13.00
Clips, 2,052	181.39
Stone, 3,299.95 cubic yards	4,800.84
Lumber, 2,533 feet B. M	38.00
Miscellaneous materials	37.30
Towing	3,600.00
Total	21,715.41

River mattress constructed, 3,099.55 squares, or 34,440 square yards. Cost in place, $7 per square, or $0.63 per square yard.

Connecting mattress.

Labor, including superintendence and subsistence	$1,714.39
Brush, 723.82 cords	665.92
Poles, 14.34 cords	20.07
Wire strand, 5,212 pounds	293.57
Wire, galvanized, 2,473 pounds	79.56
Staples, 107 pounds	3.42
Clips, 284	25.20
Stone, 741.52 cubic yards	1,078.64
Lumber, 1,533 feet B. M	23.00
Miscellaneous materials	3.94
Towing	670.96
Total	4,578.67

Connecting mattress constructed, 494.22 squares, or 5,491 square yards. Cost in place, $9.26 per square, or $0.834 per square yard.

Grading and paving.

Labor, including superintendence and subsistence	$5,426.37
Stone, 2,651.42 cubic yards	3,857.34
Lumber, 4,408 feet B. M	66.13
Coal, 4,685 bushels	493.79
Oils and engineer's supplies	156.41
Towing	1,644.00
Total	11,644.04

Bank paved, 11,898.5 square yards. Cost in place, $0.978 per square yard.

Summary of work done, with cost.

River mattress, 34,440 square yards	$21,715.41
Connecting mattress, 5,491 square yards	4,578.67
Grading and paving, 11,898.5 square yards	11,644.04
Total cost of work in the field	37,938.12

Osceola Bar, Arkansas.—After the decline of the spring high water of 1898, it was found that the revetment of this bar had sustained considerable damage, mainly along that part of its bank lying between the small chute and the head of Bullerton Towhead. This revetment had been placed here in 1890 and consisted of the old type of woven mattress, with brush and stone shore work. There is here at low

stages of river a very strong current, with direct impingement against the bank, due to the perpendicularity of the crossing and contracted waterway. Another cause operating against the stability of the work is that when the river falls below a certain stage all discharge through Bullerton Chute ceases, and the only outlet for the impounded water in rear of the bar is by seepage through the very porous soil, and this return flow causes sloughing off under the work.

The damage done was repaired during the winter of 1898 and consisted in placing fascine connecting mattresses, so as to restore the connection between the river mattress and the shore, and grading and paving the bank above low water.

In the spring of 1899 additional damage was discovered; this damage being mostly just above the repairs of the previous year, while a small fault was noticed later on just below. The former damage consisted of two caves about 300 feet apart and aggregating 940 linear feet. The damage at the lower end amounted to about 250 feet. While repairs were in progress a fresh cave took place, this being just above the main fault and adding 160 feet to the amount of repairs to be done.

The repairs of this season, like those of the previous year, consisted in placing connecting mattresses in the pocket so as to restore connection between the old river mattress and the bank, grading the bank and paving with riprap. At the lower end of the work a small washout from the main river into Bullerton Chute was closed by means of a brush and stone sill founded upon a small mattress.

Repairs were begun December 7 and completed January 7. As with all the other work of this season, progress was retarded for want of an adequate supply of stone.

Nine connecting mattresses, aggregating 891 squares, were placed; also 5,296 square yards of paving and 2,047 cubic feet of crib dike. To supplement the scant supply of stone, a good deal of the latter was gathered from the old work and from the upper part of the repairs of 1898.

An examination made here while the river was at its lowest stage showed that the entire work between the head of Bullerton Towhead and the chute above was more or less broken up along the low-water line. As all the old work along here is of the old type, it would seem that the only proper way to repair it so as to insure some degree of permanency would be the renewal of the whole work with modern construction. And in view of the direct impingement of the current and the very narrow barrier now lying between the main river and the chute, it appears important to hold the river front of the bar in order to prevent cutting through into the chute and consequent attack of Bullerton Towhead on its unprotected rear.

On the night following the completion of repairs and disbandment of the working party a cave in occurred at the very place where the bank caved during progress of repairs, and which is mentioned above as being 160 feet long. Another cave took place the following day, this one in the repairs of 1898. Both of these caves showed very plainly the cause of the damage, for not only did the caving start above the shore edge of the mattress and above the water surface, but the semifluid material underlying the drier strata could be seen flowing out.

Owing to the disbandment of the force and the absence of construction material, nothing could be done toward additional repairs. It is not believed that there will be much enlargement for one season at least. When last seen, which was twenty days after the occurrence of the damage, neither place showed any change, except that in the middle of each pocket the caving extended below the water surface.

The following is a summary of work done:

Nine connecting mattresses, total area, 891.24 squares, or 9,903 square yards.
Crib dike, 2,047 cubic feet.
Grading, 8,000 cubic yards.
Paving, 5,296 square yards.
The details of cost are as follows:

Connecting mattress.

Labor, including superintendence and subsistence	$2,370.83
Brush, 1,339.84 cords	1,232.65
Stone, 899.99 cubic yards	1,308.60
Wire strand, 6,277 pounds	370.56
Wire, galvanized, 1,481 pounds	47.69
Staples, 356.5 pounds	11.40
Clips, 520	41.08
Lumber, 866 feet B. M.	13.00
Towing	695.00
Total	6,090.81

Connecting mattress, 891.24 squares, or 9,903 square yards. Cost in place, $6.83 per square, or $0.615 per square yard.

Crib dike.

Labor, including superintendence and subsistence	$66.85
Brush, 27.26 cords	25.08
Stone, 18.24 cubic yards	26.53
Wire strand, 12.85 pounds	75.75
Staples, 9.5 pounds	.30
Towing	20.07
Total	214.58

Crib dike, 2,047 cubic feet. Cost in place, $0.104 per cubic foot.

Grading and paving.

Labor, including superintendence and subsistence	$1,418.30
Stone, 683.09 cubic yards	993.35
Coal, 375.3 bushels	39.59
Oils and engineer's supplies	33.94
Lumber, 933 feet B. M.	14.00
Towing	495.00
Total	2,994.18

Bank paved, 5,296 square yards. Cost in place, $0.565 per square yard.

Summary of work done, with cost.

Connecting mattress, 9,903 square yards	$6,090.81
Crib dike, 2,047 cubic feet	214.58
Grading and paving, 5,296 square yards	2,994.18
Total cost in the field	9,299.57

Gold Dust Dam, Tennessee.—This structure, running from the Tennessee bank to the Elmot Bar shore, and about 1¼ miles below Gold Dust Landing, was completed in January, 1894. It was built to supplement the early closure works from Gold Dust to the head of Elmot Bar, placed there in 1882–1884, and the works placed in 1889 in Elmot and Island 30 chutes. All these works were of the Pile-dike type.

Immediately after the completion of the dam a considerable settlement took place, this settling being greatest about 800 to 900 feet from the Tennessee shore. Here the structure sank down gradually until its top was about level with the bottom of the chute. Another deep depression occurred on the Elmot Bar end. In October, 1894, repairs were made. These consisted in raising the dam wherever it had settled below the 14-foot level to that height (its original elevation being 16 feet above zero, Amelia gauge), closing the two breaks, and placing a foot mattress in the hole just below the first-mentioned break. Some repairs were also made to the damaged revetment of the Elmot Bar shore. After the high water of 1895 an examination of the dam showed that further settlement had taken place. The work in the former break near the Tennessee shore had again settled down to a level with the bottom of the chute, and at the Elmot Bar end a considerable depression was again noticed. The entire dam also showed considerable settlement along nearly its entire length, it being continuous and greatest from station 20 to the Tennessee bank.

The work to be done then was the closing of the gap, building up the dam to its original elevation of 16 feet, placing a floor mattress below the Tennessee end of the dam, where a considerable hole had been scoured out by the overfall, and repairing the revetment of the Tennessee shore just below the dam. Prior to beginning work an examination was made and the following data obtained: The width of the gap measured on the water line was 91 feet; height of impounded water, 4 feet above the reading of Amelia gauge, the latter being then 0.2 above zero; that the greatest depth in the gap was 18.5 feet; that about 2,400 feet of the dam was below the 16-foot plane, requiring approximately 190,000 cubic feet of filling to restore it to that level; that the Tennessee end of the dam was somewhat undermined on the face, and that the Tennessee shore revetment below the dam was destroyed.

From station 1+40 to station 5+40 the dam was completely silted up, the deposit extending over a considerable area and being as much as 2.4 feet above the 16-foot plane. No work was to be done on this part of the dam. From station 16+55 to station 18 the elevation was also above that required by the project. Behind that

part of the dam lying between stations 0 and 18+50 there was dry bar with, however, a few deep, bowl-shaped depressions immediately behind the dam. Here the face of the dam was somewhat undermined and broken up. Behind the dam, from station 18+55 to the Tennessee bank, there was water ranging in depth from 1 foot to 17 feet below zero, the greatest depth being near the gap. These depths were immediately below the dam, and some distance farther down much greater depths could be found.

Work was begun October 21, it consisting in building portable ways upon which to construct the required mattress work, and the stripping of all stone off the crown of the dam for a width equal to the width of the base of the proposed work.

The portable ways were roughly framed out of such lumber as the sawmill at Gold Dust could furnish. The frames were so set up that there was enough water at their foot to float the fascines when the mattress was launched. To accomplish this cheaply, a brush floor was laid so as to extend out into 1 foot of water, and the frames set up on this floor. The brush was afterwards used in the construction. The mattresses were in all respects similar to the standard type, except that as the work was done in a pool devoid of current, no anchorage fastenings were required. The mattresses for the gap were constructed some distance above the place where they were to be sunk, and when a piece of mattress was finished it was swung around and dropped into place. The floor mattress for the gap had to be made in two pieces as the width of the pool did not permit of swinging around into position of the whole piece. The first mattress was fitted into the gap proper and extended far enough below to make a good lap over the mattress placed in 1894, when repairs were made. It was made wide enough to fit the shore line snugly, and in order to accomplish this it had to be partially sunk along the longitudinal middle, thus drawing the edges away from the shore. When finally sunk, the mattress flattened out and thus made a close fit. This piece averaged 115 feet in width with a length of 105 feet. The second mattress was sunk so that it overlapped the upper edge of the first one and its shape was irregular, the latter being determined by the configuration of the shore line. It contained 175 squares. The plan of completed mattress work is somewhat like the section of a funnel with an exaggerated spout.

In order to avoid deep water in the gap, and also to give the crib greater resistance against a force tending to push it out of place, the closure work was built in the form of an arch. Its greatest width of base was 72 feet, narrowing to 50 feet toward each end. Its crown was 24 feet, narrowing to 16 feet at each end. The maximum height was 21 feet, but during construction it settled so much that 2 feet had to be added in order to bring it up to the 16-foot plane. The crib was composed of five tiers, all built up into one mass. A vertical section through the middle would show that the first, second, and third tiers, counting from the bottom, are each 4 feet thick, the fourth and fifth 5 feet, and each tier stepped back 4 feet on the upstream and 8 feet on the downstream side. The whole structure where it crosses the water is 148 feet long, measured along the middle line. In construction the top of each tier was ballasted before being covered by the next one. The brush topping over the old work varied in width from 16 feet to 30 feet, according to heighth of fill, the maximum being 7.5 feet minus the allowance for compression. The top width is 16 feet. Where the fill exceeded 4 feet, two tiers, stepped back similarly to that first described, were built. In the depression on the Elmot Bar side the filling was built up with battered face and back. The total volume of filling in the gap is 130,000 cubic feet, and for the entire dam 181,534 cubic feet.

To repair the submerged part of the dam on the Tennessee end, and the shore revetment, there were placed two mattresses, aggregating 229.5 squares. The bank above water was evened up with shovels, and, as stone was scarce, instead of being paved, brush, lightly ballasted, was laid on the slope.

As all access by water to the work was cut off until toward the close of the work, all materials had to be either hauled, wheeled, or carried to place. Brush was furnished, as long as it could be hauled over the bar, by J. A. Curlin, at $1.50 per cord, delivered. No poles were purchased, as these could be sorted out from the brush.

On December 22 the river began rising, and by the 26th water began running through the new work in the gap, overtopping it the following day. The crib settled at once 2.7 feet in the middle of the gap, and continued to do so slowly. The head of water, measured on the 27th, was 4.35 feet, but was said to have been fully 5 feet the day previous, or before the pool below had filled up somewhat. The rising river seriously threatened the new work, some of which as yet had not been ballasted, so stone was hastily taken from the high places of the old work and distributed where most needed. Some was boated down from the 1882–1884 work one-half mile above, a small flat being used for that purpose, and 1,000 sacks filled with gravel

were used. The work was held during this rise—not, however, before some of it on the Tennessee side of the gap had been pushed out of alignment fully 8 feet. On December 30 one barge of riprap was received from the contractor, and this was divided into three parts, one to Fletchers Bend, one to Osceola Bar, and about 75 cubic yards for the dam. This was pushed up to the work, the chute then carrying scant 4 feet of water. A partially loaded barge of brush was also pushed up at the same time, the brush contractor being no longer able to haul on account of partial submergence of the bar.

By January 9 all work was completed, except that more stone was to be placed as soon as some would become available and could be pushed up to the dam, the water being then too low to allow anything larger than a skiff to approach the work. Stone had been in the meantime pushed up into the chute of Island No. 30, and the master laborer heretofore in local charge was instructed to take advantage of the first rise of sufficient volume to push the stone to place. The barges, three in number, were lightly laden, and as an additional precaution two empties were left with him should it become necessary to lighten the stone barges still more. The tug *Itasca* was left there to do the towing. On January 22 there was water enough to get stone to the dam, and all work was completed on the 26th; 301 cubic yards of stone were distributed over the work, and 247 yards were stored on the Tennessee bank for future use, the complete submergence of the work rendering it impracticable to distribute any more. The work, however, is now safe.

On January 29 I examined the work and found that from the gap to the Tennessee shore it was in good shape. From the gap to Elmot Bar everything was submerged. The master laborer reported that there was a break in the old work, situated about 400 feet west of the gap, and estimated to be 125 feet wide. He reported that the break occurred before the water overtopped the dam, and was due to the scouring out of the bottom.

No further examination will be possible until after high water.

The following is a summary of work done:

Building crib in gap, 130,200 cubic feet.
Topping dam, 51,334 cubic feet.
Mattress work, 525.25 squares.
Shore mattress, 115 squares.
Stone stored on bank, 247 cubic yards.

The details of cost are as follows:

Repairing dam.

Labor, including superintendence and subsistence	$3,230.77
Brush, 2,080.32 cords	3,078.14
Stone, 299.75 cubic yards	472.08
Wire, galvanized, 1,301 pounds	41.92
Wire strand, 3,680 pounds	216.39
Staples, 96.1 pounds	3.00
Nails and spikes, 167.2 pounds	3.80
Lumber, 2,608 feet B. M	33.76
Miscellaneous materials	55.78
Towing	93.00
Total	7,228.64

Repairs to dam, 181,534 cubic feet. Cost, in place, $0.0398 per cubic foot.

Mattress work.

Labor, including superintendence and subsistence	$1,384.89
Brush, 900 cords	1,350.00
Stone, 76.25 cubic yards	110.25
Wire, galvanized, 284 pounds	9.10
Wire strand, 1,896 pounds	111.53
Clips, 240	14.11
Staples, 66.9 pounds	2.09
Nails and spikes, 19.8 pounds	.41
Lumber, 2,164 feet B. M	28.00
Miscellaneous materials	3.00
Towing	16.00
Total	3,029.38

Mattress construction, 640.25 squares, or 7,114 square yards. Cost, in place, $4.73 per square, or $0.4258 per square yard.

Summary of work done, with cost.

Repairing dam, 181,534 cubic feet	$7,228.64
Mattress work, 7,114 square yards	3,029.38
Total cost of work in the field	10,258.02

Respectfully submitted.

AUG. J. NOLTY, *Assistant Engineer.*

Capt. E. EVELETH WINSLOW,
Corps of Engineers, U. S. A.

REPORT OF MR. W. M. REES, ASSISTANT ENGINEER, ON WORK IN FIRST AND SECOND DISTRICTS, DURING SEASON 1899–1900.

MEMPHIS, TENN., *April 30, 1900.*

CAPTAIN: I have the honor to submit report upon work done in First and Second districts, improving Mississippi River, during the season 1899–1900, at the following places:

1. Hickman, Ky.
2. New Madrid, Mo.
3. Hopefield Bend, Arkansas.
4. Memphis Harbor, Tennessee.
5. Helena, Ark.

1. HICKMAN, KY.

The work to be done was to repair a washout in the upper bank, caused by a surface drain, and located at about the middle of the revetment work of 1894. The bluff portions of the bank around the hole were graded first by hand; a sill placed across the center, and then a crib dike extending from the top of the bank to the unbroken revetment was placed on this sill, with the object of destroying the eddy action which was enlarging the hole. This dike was 105 feet long, with an average height of 10 feet. The crest and slopes of the dike and the edges of the hole were then paved with stone, some of which was taken from an old pile.

This work was begun December 19, 1899, and finished January 29, 1900. The long time required for the work was due to the shortage of stone. The work done consisted in placing 86 squares, equal to 956 square yards, of sill mattress; 25,600 cubic feet of crib dike; and 1,223 square yards of stone paving.

The details of cost are as follows:

Sill mattress.

Labor, including superintendence	$243.09
Towing	155.34
Brush, 56 cords	51.52
Poles, 9 cords	12.60
Stone, 27.06 cubic yards	37.61
Wire strand, one-fourth inch, 800 pounds	47.52
Wire, galvanized, No. 12, 400 pounds	14.32
Total	562.00

Sill mattress constructed, 86 squares, or 956 square yards. Cost, in place, $6.53 per square, or $0.587 per square yard.

Crib dikes.

Labor, including superintendence	$355.04
Towing	321.31
Brush, 200 cords	184.00
Poles, 20 cords	28.00
Stone, 170 cubic yards	236.30
Wire strand, one-fourth inch, 272 pounds	16.15
Wire, galvanized, No. 12, 600 pounds	21.48
Total	1,162.28

Amount of crib dike constructed, 25,600 cubic feet. Cost, in place, per cubic foot, $0.0454.

Paving bank.

Labor, including superintendence	$311.57
Towing	222.69
Stone, 200 cubic yards	278.00
Total	812.26

Amount of bank paved, 1,223 square yards. Cost per square yard, in place, $0.664.

Towing.

Labor	$479.84
Coal	219.50
Total	699.34

This has been charged into the work above described.

Summary of work done, with cost.

Sill mattress, 86 squares, or 956 square yards	$562.00
Crib dike, 25,600 cubic feet	1,162.28
Paving bank, 1,223 square yards	812.26
Total cost of work in field	2,536.54

The total length of the Hickman revetment work is 1,560 linear feet, all of which is in satisfactory condition.

2. NEW MADRID, MO.

The project for this work was to extend the revetment downstream as far as funds would permit, and to make necessary repairs to the old revetment, especially at the head, where slight undermining was threatened, and repairs to the paving and extension of the same up the bank along the city front.

The construction plant and outfit were brought from Helena, Ark., arriving at New Madrid November 26. Preparations were at once made, but delay was occasioned by the slow delivery of material. Brush and poles were purchased by contract at 92 cents per cord for the former and $1.40 per cord for the latter; stone was also obtained by contract at $1.39 per cubic yard, delivered at the works on contractors' barges.

The lateness of the season and the presence of ice in the river retarded the work, causing a complete suspension of operations from December 30, 1899, to January 29, 1900, while waiting for the ice to run out and enable the contractor to resume towing.

River mattress.—Only one regular fascine mattress was constructed. It was 900 feet long by 275 feet wide, and overlaps the mattress of 1898 about 50 feet; work of building was begun November 29 and the mattress sunk on December 16.

Connecting mattresses.—Two small connecting mattresses were placed, aggregating 106 squares, or 1,167 square yards. One was at the mouth of Dry Bayou, just at the head of the revetment, and the other was at "Cypress" drain, about 1,000 feet below this season's work. Both mattresses were designed as sills, over which the drainage water from these depressions can discharge without producing gullies in the bank.

Bank revetment.—All grading was done by hand, both for the repair work and along the fascine mattress, as the volume of earth to be removed, to produce a satisfactory slope for the paving, was too small to warrant the employment of the hydraulic method. The grading was done just a little in advance of the paving, the earth removed being cast upon the paved surface. Paving was begun December 17, 1899, and finished January 31, 1900. Along the site of the new work the paving was carried to the 25-foot stage, New Madrid gauge, and along the city front, for a length of 500 feet, the paving was extended to the top of the bank. The mouths of the two drains were also paved to carry off storm water. The total amount of this work done was 12,685 square yards, distributed as follows:

	Square yards.
Along the new mattress	6,240
Along the city front	5,945
At the mouth of Dry Bayou	167
At the mouth of "Cypress" drain	333
Total	12,685

The details of cost are as follows:

River mattress.

Labor, including superintendence	$4,331.63
Subsistence stores	898.94
Towing	1,836.34
Brush, 3,756.69 cords	3,456.76
Poles, 151.62 cords	212.16
Piling, 292 linear feet	23.16
Stone, 1,415.23 cubic yards	1,967.17
Staples, 300 pounds	11.70
Wire strand, one-half inch, 6,512 pounds	332.11
Wire strand, five-sixteenths inch, 10,021 pounds	642.30
Wire strand, one-fourth inch, 12,800 pounds	760.32
Wire, galvanized, No. 12, 6,800 pounds	258.40
Wire, silicon bronze, No. 9, 686 pounds	136.70
Clips, one-half inch, 200	22.30
Clips, five-sixteenth inch, 3,000	237.00
Coal	88.00
Lumber	25.75
Miscellaneous materials	47.23
Total	15,287.27

River mattress constructed, 2,475 squares, or 27,500 square yards. Cost in place, $6 176 per square, or $0.556 per square yard.

Connecting mattress.

Labor, including superintendence	$248.31
Subsistence stores	46.60
Towing	106.88
Brush, 270.15 cords	248.53
Stone, 80 cubic yards	122.32
Wire strand, five-sixteenths inch, 280 pounds	16.15
Wire strand, one-fourth inch, 830 pounds	49.30
Wire, galvanized, No. 12, 503 pounds	19.11
Miscellaneous materials	10.00
Total	867.70

Connecting mattress constructed, 106 squares, or 1,178 square yards. Cost in place, $8.186 per square, or $0.737 per square yard.

Bank revetment.

Labor, including superintendence	$3,500.10
Subsistence stores	596.85
Towing	1,067.88
Stone, 2,338.61 cubic yards	3,250.66
Spalls, 384.61 cubic yards	534.60
Coal	53.30
Miscellaneous materials	33.69
Total	9,037.08

Amount of bank paved, 12,685 square yards. Cost in place, $0.713 per square yard.

Towing.

Labor, including subsistence service	$1,804.49
Subsistence stores	141.20
Coal	1,038.77
Oils and engineer's supplies	24.92
Miscellaneous materials	1.72
Total	3,011.10

This has been charged into the work above described.

Summary of work done, with cost.

River mattress, 900 linear feet, 27,500 square yards	$15,287.27
Connecting mattress, 1,511 square yards	867.70
Bank revetment, 12,685 square yards	9,037.08
Total cost of work in the field	25,192.05

New work completed this season, 850 linear feet, cost, $19,737.39. Cost per linear foot of bank revetted, $23.32.

The present length of the New Madrid revetment is 4,500 linear feet, all in good condition.

3. HOPEFIELD BEND, ARKANSAS.

The lower portion of Hopefield Bend was revetted in 1888, 1890, and 1892, with mattresses 200 feet wide, made by weaving brush around longitudinal poles. This form of mattress presents frequent and large interstices, through which currents of high velocity will scour the material beneath, resulting in a settling of the mattress and causing breaks in the revetment, which, during high-water periods, soon results in the formation of large pockets in the bank. Such breaks occurred during the high water of 1893, 1897, and 1898.

In the fall of 1893 fascine mattresses were placed over some of the old-style mattresses at and near the lower end of the bend. About 900 linear feet were thus revetted at the extreme lower end and 2,000 linear feet a short distance above, leaving an interval of old mattress work about 1,300 feet long between the two pieces. The floods of 1897 and 1898 caused breaks along this interval and two rather serious caves in the old work above.

The project for this season was to cover this interval with a fascine mattress and to extend the same kind of work upstream about 1,900 feet in order to more thoroughly protect the endangered bank; also to make some repairs to the revetment above the low-water line, the mattresses to be 250 feet wide, with inshore edge at or about the zero contour.

Preparations for the work were begun August 1 and field work started August 16.

Brush and poles were furnished by contractors at 92 cents per cord for the former and $1.40 per cord for the latter. Stone was delivered by contractor on Government barges at West Memphis at $1.44 per cubic yard for riprap and $1.29 per cubic yard for spalls. The labor supply was abundant, and wages were $1.40 per day without subsistence. The weather and stage of river were both favorable, only four days were lost by rain, and the maximum stage of the river during the time of construction of river mattresses was 5.5 feet.

River mattresses.—The first mattress was swung into position August 21 and sunk September 9. This mattress covered the interval in the 1893 work and protects 1,415 linear feet of bank, or from station 77+65 to station 91+80. The mattress was 1,450 feet long by 250 feet wide and was built and sunk in the manner described in previous reports. Mattress No. 2, 900 feet by 250 feet, was begun September 15 and sunk September 28. It protects 880 linear feet of bank just at the head of the 1893 revetment, or from station 49+30 to station 57+10. Mattress No. 3, 1,000 feet by 250 feet, was begun October 2 and sunk October 19. It is immediately above mattress No. 2 and protects 970 feet of bank, or from station 39+60 to station 49+30.

The combined length of these three mattresses placed was 3,350 feet, revetting 3,265 linear feet of bank 250 wide below the low-water line.

The lower portion of this bend is now covered with fascine mattresses for a length of 6,015 feet, or from station 39+60 to station 99+15, the latter being at Hopefield Point.

Connecting mattresses.—Six connecting mattresses were placed along the inshore edge of the large mattresses, and one small mattress was sunk at the extreme lower end of the work to act as a sill for a stone dike or groin built there. The quantity placed was 1,036 squares, equal to 11,511 square yards.

Bank revetment.—Paving was done at numerous places, and considerable additional stone was placed along the edge of the river mattresses or near the low-water line. At several localities where the bank was being scoured above the paving it was extended to a higher contour. Several breaks or faults were found in the paving, and here the stone was removed, the bank graded to a proper slope, and then repaved.

The quantity of paving done was 3,060 square yards.

Crib dike.—A brush and pole crib dike, placed on a heavy sill mattress and paved with stone, was built across a depression scoured between the top edge of the paving

and the bank at Station 80. This dike is supplemental to those built in 1897. It connects the top of the bank with the paved slope at the 15-foot elevation above zero stage, has a length of 88 feet, average height of 10 feet, and contains 27,000 cubic feet.

Stone dikes.—A heavy paving of stone about 2 feet thick, 20 feet wide at the zero contour, and tapering to 10 feet wide at the top of the bank was placed at the extreme lower end of the revetment in order to check the extension of the caving bank upstream. It contains 3,600 cubic feet of stone.

The details of cost are as follows:

River mattress.

Labor, including superintendence	$15,703.68
Subsistence stores	894.59
Towing	2,245.40
Brush, 11,060.25 cords	10,175.43
Poles, 732.3 cords	1,025.22
Piling, 600 linear feet	48.00
Stone, 4,204.42 cubic yards	6,054.36
Staples, 1,150 pounds	37.79
Wire strand, one-half inch, 6,025 pounds	315.16
Wire strand, five-sixteenths inch, 31,339 pounds	1,551.28
Wire strand, one-fourth inch, 42,192 pounds	2,506.20
Wire, galvanized, No. 12, 20,020 pounds	644.64
Wire, silicon bronze, No. 9, 3,100 pounds	615.04
Clips, one-half inch, 800	90.40
Clips, five-sixteenths inch, 8,000	632.00
Lumber	51.80
Coal	48.00
Charter of barges	300.00
Miscellaneous materials	251.57
Total	43,190.56

River mattress constructed, 8,375 squares, or 93,056 square yards. Cost in place, $5.157 per square, or $0.464 per square yard.

Connecting mattress.

Labor, including superintendence	$1,931.28
Subsistence stores	108.31
Towing	268.60
Brush, 1,553.31 cords	1,429.04
Poles, 65.5 cords	91.70
Stone, 474 cubic yards	682.56
Staples, 150 pounds	5.01
Wire strand, one-half inch, 270 pounds	14.12
Wire strand, five-sixteenths inch, 2,000 pounds	99.00
Wire strand, one-fourth inch, 3,758 pounds	223.23
Wire, galvanized, No. 12, 3,200 pounds	103.04
Charter of barges	80.00
Coal	6.00
Miscellaneous materials	24.00
Total	5,065.89

Connecting mattress constructed, 1,036 squares, or 11,511 square yards. Cost in place, $4.889 per square, or $0.44 per square yard.

Bank revetment.

Labor, including superintendence	$1,789.78
Subsistence stores	70.74
Towing	252.84
Stone, 1,253.32 cubic yards	1,804.78
Spalls, 485.02 cubic yards	625.68
Lumber	98.32
Miscellaneous materials	23.31
Total	4,665.45

Total amount of paving placed, 3,060 square yards. Cost per square yard, $1.521.

Crib dikes.

Labor, including superintendence	$495.33
Subsistence stores	42.96
Towing	64.69
Brush, 57.5 cords	52.90
Poles, 45 cords	63.00
Stone, 250 cubic yards	360.00
Wire strand, one-fourth inch, 24,000 pounds	142.56
Total	1,221.44

Total amount of crib dike constructed, 27,000 cubic feet. Cost per cubic foot, $0.045.

Stone dikes.

Labor, including superintendence	$81.87
Subsistence stores	6.60
Towing	21.00
Stone, 200 cubic yards	288.00
Total	397.47

Total amount of stone dike constructed, 3,600 cubic feet. Cost per cubic foot, $0.11.

Towing.

Labor, including subsistence service	$1,762.99
Subsistence stores	259.03
Coal	682.00
Oils and engineer's supplies	65.90
Miscellaneous materials	82.61
Total	2,852.53

This has been charged into the works above described.

Summary of work done, with cost.

River mattress, 3,350 linear feet, or 8,375 squares	$43,190.56
Connecting mattress, 1,036 squares	5,065.89
Bank revetment, 3,060 square yards	4,665.45
Crib dikes, 27,000 cubic feet	1,221.44
Stone dikes, 3,600 cubic feet	397.47
Total cost of work in the field	54,540.81

The upper 4,000 feet of the Hopefield Bend revetment has river mattresses of the old style, 200 feet wide. These have protected this portion of the bend since 1891. Along the lower 6,000 feet, where the current is strongest, there is now a continuous belt of fascine mattresses 250 to 300 feet wide. The bank above low water for the entire length is paved with stone up to the 24-foot stage, as an average. Above this paving considerable scour has occurred during recent high waters, leaving in many places a nearly horizontal bench from 15 to 30 feet wide, and at some places this scouring was so great that large troughs were excavated far below the top edge of the paving. These, however, have been repaired by building 9 crib dikes across them, 8 in 1897 and 1 in 1899.

Owing to the importance of this revetment to the preservation of the harbor of Memphis, it is recommended that the paving be extended to the top of the bank. Since the fall of 1893 the caving at the lower end of the revetment has transferred Hopefield Point upstream 250 feet. To prevent further loss the revetment should be extended around the point about 400 feet.

4. MEMPHIS HARBOR, TENNESSEE.

The work consisted in repairing some of the dikes along the Memphis front, built by the citizens in 1886 and later extended and several times repaired by the Government.

Recent high waters had scoured pockets below Dikes Nos. 1 and 2, and to prevent further enlargement a connecting mattress 150 feet long by 130 feet wide was placed in each, and along the lower pocket the bank above low water was paved with stone up to the 16-foot stage on Memphis gauge.

Dikes Nos. 2 and 2½ were also repaired. Additional brush cribs had been placed on the shore ends of these in 1897; but as the brush work of which they were composed was fast decaying, it was considered advisable to preserve them. To this end wedge-shaped cribs of brush work were built on their sides, shaped to a slope of 1 on 1½, and then closely paved with stone.

The mattress and crib work was placed between October 20 and October 31, using the plant from the Hopefield Bend work, but the stone paving was not placed until some time later. The dike work is now in fair condition, but repairs will probably be needed from time to time.

The details of cost are as follows:

Connecting mattress.

Labor, including superintendence	$587.87
Towing	28.08
Brush, 500 cords	460.00
Stone, 406 cubic yards	564.17
Staples, 100 pounds	3.63
Wire strand, five-sixteenths inch, 1,500 pounds	74.25
Wire strand, one-fourth inch, 2,000 pounds	118.80
Wire, galvanized, No. 12, 400 pounds	12.88
Total	1,849.68

Connecting mattress constructed, 391 squares, 4,344.4 square yards. Cost in place, $4.73 per square, or $0.4257 per square yard.

Crib dikes.

Labor, including superintendence	$371.59
Brush, 222.86 cords	205.03
Stone, 100 cubic yards	144.00
Wire strand, five-sixteenth inch, 472 pounds	23.36
Wire, galvanized, No. 12, 400 pounds	12.88
Total	756.86

Total amount of crib dikes constructed, 23,700 cubic feet. Cost per cubic foot in place, $0.032.

Paving.

Labor, including superintendence	$343.31
Stone, 250 cubic yards	360.00
Spalls, 166 cubic yards	214.14
Total	917.45

Amount of paving laid, 1,137 square yards. Cost per square yard in place, $0.807.

Summary of work done, with cost.

Connecting mattress, 391 squares, or 4,344.4 square yards	$1,849.68
Repairs to crib dikes, 23,700 cubic feet	756.86
Paving, 1,137 square yards	917.45
Total cost of work in the field	3,523.99

5. HELENA, ARK.

In 1889, when the first work was done at this harbor, a mattress 613 feet long by 226 feet wide was placed from the steamboat elevator extending downstream, but along this the bank was neither graded or paved. Below this mattress there was 450 feet of unrevetted bank extending to the sill mat of Dike No. 1. Along the portion above described active caving of the bank (especially the lower half) had recently occurred, and the project was to complete this revetment by placing across the gap a fascine mattress, join the 1889 mattress with the bank by connecting mattress, and to grade and pave along the whole; also to make necessary repairs to the other work.

The plant used on this work was the same as at Hopefield Bend. On October 4 a pile driver and crew arrived and on the following day began work at grading the bank; the mattress-building plant arrived from Hopefield Bend on November 5, and, its work being completed, was sent to New Madrid, Mo., on November 21, a small

self-subsisting force being left to finish the paving work. Brush, poles, and stone were furnished by same contractors and at same prices as at Hopefield Bend. The season was good and labor plentiful.

River mattress.—One river mattress was built, connecting the mattress of 1889 with Dike No. 1; it was 600 feet long by 250 feet wide; was begun November 6 and sunk November 16.

Connecting mattress.—Two connecting mattresses, about 40 feet wide each and aggregating 185 squares, were placed along the 1889 work, and 1 mattress 60 feet by 100 feet was placed below Dike No. 4 to join the sill of that dike with the work below.

Bank revetment.—Grading with pile-driver pumps was begun October 5 and continued daily until finished on November 18. The grading extended from the elevator to Dike No. 1, a length of 1,050 feet. Volume of material removed, 13,267 cubic yards; total cost, $1,867.45; cost per linear foot of bank, $1.78, and cost per cubic yard, $0.14. The high cost is due, first, to the tenacity of the material, and second, to the presence of a large quantity of riprap stone which had been silted up just on top of the graded bank. The paving was begun November 17 and completed December 22, after considerable delay in awaiting the arrival of stone. It was carried to the 21-foot stage of the Helena gauge.

Repairs to dikes.—The work consisted in placing a brush and pole crib, containing 17,400 cubic feet, on Dike No. 4 to restore a settled portion of the old work, and the repaving of the shore ends of Dikes Nos. 1½, 2, and 2½. The amount of repairing thus done aggregates 1,100 square yards.

The details of cost are as follows:

River mattress.

Labor, including superintendence	$2,228.67
Subsistence stores	354.57
Towing	1,127.94
Brush, 1,910.49 cords	1,757.65
Poles, 120 cords	168.00
Piling, 120 linear feet	9.60
Stone, 1,000 cubic yards	1,440.00
Staples, 200 pounds	7.30
Wire strand, one-half inch, 1,100 pounds	57.53
Wire strand, five-sixteenths inch, 6,000 pounds	297.00
Wire strand, one-fourth inch, 8,000 pounds	475.20
Wire, galvanized, No. 12, 6,000 pounds	214.80
Wire, silicon bronze, No. 9, 500 pounds	99.20
Clips, one-half inch, 200	22.60
Clips, five-sixteenths inch, 2,000	158.00
Coal	40.00
Lumber	59.31
Charter of barges	204.00
Miscellaneous materials	12.61
Total	8,733.98

Mattress constructed, 1,500 squares, or 16,667 square yards. Cost in place, $5.82 per square, or $0.524 per square yard.

Connecting mattress.

Labor, including superintendence	$532.07
Subsistence stores	127.46
Towing	205.50
Brush, 300 cords	276.00
Poles, 42.5 cords	59.50
Stone, 150 cubic yards	216.00
Staples, 100 pounds	3.60
Wire strand, one-fourth inch, 2,000 pounds	118.80
Wire, galvanized, No. 12, 1,000 pounds	35.80
Coal	10.00
Miscellaneous materials	10.28
Total	1,595.01

Connecting mattress constructed, 245 squares, or 2,722 square yards. Cost in place, $6.51 per square, or $0.586 per square yard.

Bank revetment.

Labor, including superintendence	$3,640.28
Subsistence stores	89.81
Towing	901.63
Stone, 1,154.43 cubic yards	1,662.38
Spalls, 298.3 cubic yards	384.81
Coal	278.00
Oils and engineer's supplies	16.83
Miscellaneous materials	13.39
Total	6,987.13

Amount of paving laid, 9,500 square yards. Cost per square yard in place, $0.735.

NOTE.—Considerable stone was obtained from old stock pile, which was undercut by grading. This stone had heretofore been expended.

Repairs to dikes.

Labor, including superintendence	$512.86
Subsistence stores	4.58
Towing	114.00
Brush, 41.25 cords	37.95
Stone, 140 cubic yards	201.60
Miscellaneous materials	11.75
Total	882.74

Amount of crib dike constructed, 17,400 cubic feet. Cost in place, $0.0507 per cubic foot.

Towing expense.

Labor, including superintendence	$1,161.85
Subsistence stores	193.67
Coal	782.33
Oils and engineer's supplies	8.55
Charter of steamer	200.00
Miscellaneous materials	2.67
Total	2,349.07

This has been charged into the various works described above.

Summary of work done, with cost.

River mattress, 600 linear feet, or 1,500 squares	$8,733.98
Connecting mattress, 245 squares	1,595.01
Bank revetment, 9,500 square yards	6,987.13
Repairs to dikes, 17,400 cubic feet	882.74
Total cost of work in the field	18,198.86

The total length of the Helena revetment is 4,900 feet, including the dike system. There is, however, one entirely unrevetted space of 220 feet in length between dikes Nos. 3 and 4. The bank here, above low water line, is quite tenacious, and the dikes have thus far prevented erosion from below. It is probable that ere long further repairs will be required to the dikes and that the paving will require extension to nearer the top of the slope.

The bank at two localities appears to be in a rather unstable condition; thus in the fall of 1898 a long crack opened from the Hoop Mill incline to and across dike No. 6, on about the top line of the paving, the lower portion of the bank settling fully 2 feet, and in the fall of 1899 another crack, higher up the bank, opened in the same locality, but extended up-stream farther, or to dike No. 5½. Similar faults were observed in 1899 at the shore ends of dikes Nos. 1 and 2.

The works at the above-named points were under the immediate supervision of Mr. Louis Haas, overseer, to whose skill and ability much of the success is due.

Respectfully submitted.

W. M. REES, *Assistant Engineer.*

Capt. E. EVELETH WINSLOW,
Corps of Engineers, U. S. A.

REPORT OF MR. CHARLES LEVASSEUR, ASSISTANT ENGINEER, ON DREDGING OPERATIONS IN WOLF RIVER, SEASON OF 1899–1900.

MEMPHIS, TENN., *April 30, 1900.*

CAPTAIN: I have the honor to submit the following report on the dredging operations in Wolf River from August 1 to December 21, 1899:

The object of the work was to keep open the channel of Wolf River from its mouth to the county bridge during the low-water season.

For this season's work the beam of the dipper was lengthened, and operations were resumed in the same manner as during the previous year—that is, the material dredged was dumped on the channel bank. Work was begun in August and was carried on without interruption to December 21. Most of the work was done near the mouth of the river and in the channel across the sand bar. The material dredged was very soft mud that had filled in during the preceding high water, and a large part of it, after being dumped on the bank, slipped back into the channel. No dump scows were available or obtainable, and the work was continued in said manner.

Although navigation was improved this year by dredging, operations can not, on the whole, be considered a success. Navigation was impeded for a period of three months. But this season the river conditions were most unfavorable and the plant insufficient. The Mississippi River remained at a relatively high stage until late in August, and then began to drop with great rapidity. The dredge was unable to lower the bottom as fast as the surface fell. The deposit during the previous high water was greater than ever known before. When the Mississippi River began to fall the discharge of Wolf River was very small and remained so during the entire season; consequently this stream was unable to do its usual amount of scouring and so help the dredging operations.

The table below will show the number of cubic yards dredged, the locality of dredging; also the number of cuts, dippers, the average cut, and time:

Locality.	Number of days dredging.	Number of cuts.	Number of dippers.	Average cut.	Cubic yards dredged.
				Feet.	
From mouth to railroad incline	89	586	15,014	4	19,738
From railroad incline to Loosa Hatchie	31	196	4,938	4.5	7,407
From Loosa Hatchie to first railroad bridge	23	119	3,860	4.2	5,715
Total	143	901	23,812	4.2	32,860

Length dredged, 11,400 feet.

During this season's work one hundred and twenty hours were lost on account of repairs to machinery.

The cost of the dredging operations, including superintendence, cost of repairs, coal, and engineer's supplies, was $3,469.23, as follows:

Labor	$2,986.32
Coal	263.00
Oils and engineer's supplies	33.74
New chain and iron work	151.49
Miscellaneous materials	34.68
Total	3,469.23

Respectfully submitted.

CHAS. LEVASSEUR, *Assistant Engineer.*

Capt. E. EVELETH WINSLOW,
Corps of Engineers, U. S. A.

REPORT OF MR. AUG. J. NOLTY, ASSISTANT ENGINEER, ON CARE OF AND REPAIRS TO PLANT FOR YEAR ENDING APRIL 30, 1900.

MEMPHIS, TENN., *April 30, 1900.*

CAPTAIN: I have the honor to submit my annual report of the operations of the "Care of and repairs to plant" party at Memphis, Tenn., for the twelve months ending April 30, 1900.

Steamer Chisca.—A new set of grate bars for the furnaces, a new piston for the starboard main engine, and a new rudder stock were made for this boat. While in commission in October the boat struck a submerged obstruction, breaking some of the

floor timbers in the port bow and damaging the forward capstan engines. Repairs were made in the field. This boat will require a new dynamo engine, the old one having been wrecked beyond repair toward the close of the working season.

Steamer Titan.—Bids having been invited from various boat-builders along the Ohio and Mississippi rivers for the docking and repair of this boat, the contract for such repairs was awarded to the American Boat Works, of St. Louis, Mo., they being the lowest bidders. The bid of this firm was extremely low, but inquiries relative to their financial and professional standing failed to disclose anything that would justify the rejection of their bid. The time limit was specified as ninety days after award of contract.

The *Titan* arrived at St. Louis on March 18, but owing to various delays, some due to continued oscillations of the river, others due to unpreparedness of the contractors, it was not until the end of April that the boat was finally hauled out on the ways. These latter were not regular fixed marine ways, but improvised ones. Owing to very faulty choice of location of these ways, the boat could not be hauled up above the ordinary high-water plane, and as the river remained quite high during the greater part of the spring and summer, this, combined with dilatoriness in getting the requisite timber, delayed the actual beginning of repairs until August 1. Even after that date about ten days were lost by reason of not having the required material on hand when wanted. These delays were toward the end of August augmented by financial difficulties in which the firm became involved. Two extensions of time had already been granted, and upon the expiration of the second extension, August 31, it became evident that the contractors would be unable to complete the work in time for the boat to be of any service to us during the season. Hence, on September 1 the United States assumed charge of the work. The boat was launched October 3, but owing to a premature movement of the bow end while the stern remained fixed, the boat, instead of sliding down, slewed around, dropping the forward end partially off the ways, suffering, however, but slight damage thereby. The boat was jacked up, launched completely, and the damage repaired, being finally completed October 24, upon which day it left for Plum Point, arriving there on October 27 and going at once into service. Subsequently the boat had to be sent to Memphis to have leaky boiler calked and a corroded sheet cut out of the forward mud drum. The donkey boiler having failed while undergoing the test, another one on hand on the works was put in.

Steamer Graham.—The furnaces of this boat were rebuilt. The hurricane roof was repaired and re-covered. Other and minor repairs were made during the season. This boat will require a new cabin, the present one being the original one built in 1879, and is now irreparable.

Steamer Itasca.—In an unavoidable collision with the stage of the steamer *Kate Adams* the pilot house of the *Itasca* was completely wrecked. A new one was built and all the machinery put into good working condition.

Steamer H. L. Abbot.—This boat received only minor repairs.

Floating dock.—This dock had been built in 1889, and had received but little repair since, and needed them badly. Bids for the repair to this dock were invited from various boat yards along the Ohio and Mississippi rivers. The bids were much too high and asked for too much time in which to complete the job. As very little of the repairs to plant conld be done without the dock, it was decided that the repairs should be done here with a hired force. A suitable piece of bank was prepared, and as soon as the stage of water permitted the dock was placed on the blocking prepared for it.

The repairs made were as follows: Entirely new false bottom; calking of both the false and main bottom; new sides, except the bottom strake, which was still sound; new ends, except gates; new silas posts; new timber heads; new side shores; new keel blocks; sea valves reground; ejector pipes renewed: ejector gates replaned and reground, and dock calked all around. The dock was launched May 18 and immediately put into service.

Dredge Wolf.—The alterations to this machine, mention of which was made in my last report, were completed July 10. The following is a summary of changes and repairs: Boom lengthened 10 feet; dipper handle lengthened 6 feet; new steel nose fitted on dipper: stiffening truss put up under upper transverse chord; hull calked; general repairs to machinery, and cabin repaired. The lengthening of the boom and of the dipper handle necessitated the lengthening of all chains and tie rods. This machine is in good condition, but needs docking for the purpose of calking.

Quarter boats.—There are 11 quarter and office boats. They were all repaired and calked where necessary. All are now in good condition.

Grader No. 2.—This boat's hull and deck were calked, a new water chamber for one of the main pumps was fitted up, and all machinery was thoroughly overhauled. This machine should be docked in order to permit of the readjustment and repair of the trusses under the heavy main pumps.

Grader No. 40.—The hull was patched and calked. The heavy weights of the main

pumps occupying but a small floor space, caused the deck and bottom to sag badly. As the depth of hold was too shallow to permit of the erection of serviceable under-deck trusses to carry these weights, two overhead ones were built.

Pile drivers Nos. 19 and 20.—The hulls and cabins were repaired and the machinery overhauled. The boiler on No. 20 being no longer serviceable, another was obtained from the warehouse at Elmot and put on board.

Machine boat No. 1.—On August 17 the boiler supplying the engine exploded, slightly scalding the machinist and wrecking part of the roof and one side of the cabin. A boiler was obtained from the warehouse at Elmot and set up. All other damage was repaired.

Machine boat No. 2.—This boat is no longer serviceable and is awaiting inspection and condemnation.

Lifting camels.—The two pontons constructed the previous year for use in operations on Nonconnah Rock were, at a small expense, converted into lifting camels for the purpose of raising the ends of barges that were to be repaired, without docking. They answered very well for this purpose.

Mooring barges 1 and 2.—These were built in 1891. They were docked and almost completely rebuilt.

Mooring barges 203, 209, 213, and 229.—These are barges of the "framed" type and were converted into mooring barges. They were docked, repaired, and strengthened.

Mattress barges.—Two of the 1893 gunwale barges were converted into mattress barges to replace some condemned the previous year. Their free-board being too high, the sides were cut down, the deck was lowered, and the ways and other appliances erected. Several improvements over the old style of mattress barge were incorporated, one, the substitution of movable for the fixed wooden fascine formers. Another improvement is, that instead of having special strand reels fitted, the new barges are so arranged that the ordinary reels upon which the strand leaves the factory can be lifted into the frames under deck, thus saving the time lost in rewinding from the commercial onto the barge reel.

Four of the old mattress barges were repaired as well as could be done without docking, there not being time enough for this. These four are in very poor condition and will require extensive repairs.

Barges.—These were repaired where necessary. They all need additional repairs before they can be used for another season.

Miscellaneous repairs.—In addition to the work enumerated above, a large amount of miscellaneous repairs were done to the skiffs and other tools and outfit. The cables were cleaned, and a number of small articles were constructed.

The plant has at all times been properly cared for by the small force retained for that purpose.

Cost of repairs to plant for the season of 1899 and 1900.

Steamer *Chisca*	$597.95
Steamer *Titan*	6,647.31
Steamer *Graham*	225.87
Steamer *Itasca*	125.52
Steamer *Abbot*	14.49
Floating dock	3,951.19
Dredge *Wolf*	1,419.67
Quarter boats (11 of them)	3,259.35
Hydraulic grader No. 2	776.84
Hydraulic grader No. 40	234.61
Pile drivers 19 and 20	240.45
Machine boats 1 and 2	461.09
Lifting camels	79.78
Mooring barges 1 and 2	1,932.07
Mooring barges 203, 209, 213, and 229	4,192.80
Mattress barges	1,106.66
Barges (29 of them)	9,619.79
Cleaning cables	143.05
Miscellaneous repairs	1,343.22
Total	36,371.71

The cost of caring for the plant, including superintendence and towing, was $18,889.17.

Respectfully submitted.

AUG. J. NOLTY, *Assistant Engineer.*

Capt. E. EVELETH WINSLOW,
Corps of Engineers, U. S. A.

Abstract of proposals for levee work in Upper and Lower St. Francis, White ... Upper Yazoo Levee districts, received in response to advertisements dated Jun and opened July 3, 1899, by Capt. E. Eveleth Winslow, Corps of Engineers.

No.	Name and address of bidder.	Upper St. Francis Levee district Birds Point.	Lower St. Francis Levee dist...				
			Rankin's mill.	Loop at ...	Station ... to ...	Station ... to ...	Stat...
		Cents.	Cents.	Cents.	Cents.	Cents.	Cen...
1	John F. Keeney, Cairo, Ill	a 12.99	.....	.....	.....	.....	.....
2	John T. Hillsman, Memphis, Tenn. b	13	.....	a 13	.....	a 13.50	a 12
6	Thomas Bros., Memphis, Tenn	13	.....	.....	.....	.....	.....
7	T. Mike, Greenville, Miss. c	13	15	12.50	14.50	14.49	12.
8	W. M. Bates, Peters, Ark. d	18	a 15	.....	a 14	16	15.
9	W. T. Montgomery & Bro., Memphis, Tenn	22.95	15	15	18	20	14.
10	Robert Johnsen, Memphis, Tenn. b	19.49	19.49	19.49	19.49	19.49	19.
11	Arnold & Co., Memphis, Tenn	16	16	20	16	17	14.
12	McCadden & Co., Memphis, Tenn. b	17.50	17.50	17.50	17.50	17.50	17.
13	James H. Carey, Memphis, Tenn. b	15	14.50	14.50	14.50	14.50	14.

No.	Name and address of bidder.	Lower St. Francis Levee district.				
		Station ... to ...	Station ... to ...	Station ... to ...	Station ... to ...	Stati... to ...
		Cents.	Cents.	Cents.	Cents.	Cent...
2	John T. Hillsman, Memphis, Tenn. b	.....	a 12	a 13	.....	.....
7	T. Mike, Greenville, Miss. c	a 12.90	12.90	12.40	30	a 14
8	W. M. Bates, Peters, Ark. d	14	14	15	a 25	20
9	W. T. Montgomery & Bro., Memphis, Tenn	15	14.80	15.80	.....	.....
10	Robert Johnsen, Memphis, Tenn. b	19.49	19.49	19.49	19.49	19.
11	Arnold & Co., Memphis, Tenn	16	14.50	15.50	.....	.....
12	McCadden & Co., Memphis, Tenn. b	17.50	17.50	17.50	17.50	17.
13	James H. Carey, Memphis, Tenn. b	14.50	14.50	14.50	.....	.....

No.	Name and address of bidder.	White River Levee district.			Upper Yazoo Levee			
		Station ... to ...	Station ... to ...	Station ... to ...	North ... section 76 and sec. 75.	Sections 74 and 73.	Sections 72, 71, 70, and 69.	...
		Cents.	Cents.	Cents.	Cents.	Cents.	Cents.	
3	Bush Bros. & Sessions, Friars Point, Miss. g	18	f 24.95	f 24.90	20	22.50	17	
4	McCarten & Lucas, Friars Point, Miss	.....	.....	.....	.....	.....	.....	
5	Aderholdt & Lowrance, Friars Point, Miss. c	.....	.....	.....	11.50	19	12.40	a
6	Thomas Bros., Memphis, Tenn	a 13	f 30	f 30	.....	.....	.....	
8	W. M. Bates, Peters, Ark. d	14.70	f 27	f 27	16	27	16	
10	Robert Johnsen, Memphis, Tenn. b	.....	.....	.....	23.49	23.49	23.49	
11	Arnold & Co., Memphis, Tenn	13½	f 32	f 27½	14	21.25	15	
14	P. H. Rogers, Bledsoe, Ark	13.96	.....	.....	.....	.....	.....	

a Accepted.
b Wants all or none.
c Will not take more than 300,000 cubic yards.
d Will not take more than 200,000 cubic yards.
e Will take all from section 76 to 70, inclusive, at 14.94 cents per cubic yard ac...
f Rejected.
g Will not take more than 150,000 cubic yards.

Prices bid are per cubic yard.

Abstract of proposals for furnishing brush, poles, stone, wire, wire strand, silicon bronze wire, wire rope clips, staples, and manila rope, received in response to advertisement dated June 8, 1899, and opened July 5, 1899, by Capt. E. Eveleth Winslow, Corps of Engineers.

No.	Name and address of bidder.	Brush, per cord.	Poles, per cord.	Stone, per cubic yard, on contractor's barges at—							
				New Madrid, Mo.		Caruthersville, Mo.		Plum Point Reach.		Hopefield Bend.	
				Riprap.	Spalls.	Riprap.	Spalls.	Riprap.	Spalls.	Riprap.	Spalls.
1	John Barrett & Son, Cincinnati, Ohio	.....	.....	$1.43	$1.43	a $1.44	a $1.44	$1.54	$1.54	$1.74	$1.74
3	Frederick Hartweg, Cincinnati, Ohio	.....	.....	a 1.39	a 1.39	1.46	1.46	a 1.47	a 1.47	1.67	1.67
7	Joseph Evins, Dardanelle, Ark.	$1.15	$1.75	.....	.....	.....	.....	.....	.....	.....	.....
9	K. H. Killebrew & Co., Mount Pleasant, Tenn	.99	1.20	.....	.....	.....	.....	.....	.....	.....	.....
13	Hunter & Frey, Memphis, Tenn.	a .92	a 1.40	.....	.....	.....	.....	.....	.....	.....	.....

No.	Name and address of bidder.	Stone, per cubic yard.						Wire No. 12, B.W.G., per pound.
		On contractor's barges at Helena, Ark.		On Government barges at Memphis.		On Government barges at quarries.		
		Riprap.	Spalls.	Riprap.	Spalls.	Riprap.	Spalls.	
						Cents.	*Cents.*	*Cents.*
1	John Barrett & Son, Cincinnati, Ohio	$1.87	$1.87	.....	.....	.....	.....	.....
3	Frederick Hartweg, Cincinnati, Ohio	1.94	1.94	.....	.....	.....	.....	.....
4	Harry E. Coffin, Memphis, Tenn.	.....	.....	.....	.....	.....	.....	a 3.22
6	John F. Oliver, Neelys Landing, Mo	.....	.....	.....	.....	49.50	48	.....
9	K. H. Killebrew & Co., Mount Pleasant, Tenn	.....	.....	.....	.....	49.90	49.9	.....
10	John T. Hillsman, Memphis, Tenn	.....	.....	.....	.....	98	97	.....
11	Manogue-Pidgeon Iron Co., Memphis, Tenn	.....	.....	.....	.....	.....	.....	3.29
12	Edward Hely, Louisville, Ky	.....	.....	a $1.44	a $1.29	.....	.....	.....
16	American Steel and Wire Co., Chicago, Ill	.....	.....	.....	.....	.....	.....	3.18
17	Phil J. Howard, Rosiclare, Ill	.....	.....	.....	.....	47	40	.....

No.	Name and address of bidder.	Wire strand.			Silicon bronze wire, per pound.	Wire rope clips.		Staples, per pound.	Manila rope, per pound.
		¼-inch, per pound.	⅜-inch, per pound.	½-inch, per pound.		⅜-inch, each.	½-inch, each.		
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	American Manufacturing Co., New York, N. Y	.....	.....	.....	.....	.....	.....	.....	9.60
4	Harry E. Coffin, Memphis, Tenn.	a 5.94	a 4.95	a 5.23	a 19.84	8.50	12.50	.....	9.76
5	Lee Bros., Memphis, Tenn	.....	.....	.....	.....	.....	.....	.....	a 9.57½
8	George Skene, Memphis, Tenn.	6.065	5.12	5.27	.....	a 7.90	a 11.30	3.75	.....
11	Manogue-Pidgeon Iron Co., Memphis, Tenn	.....	.....	.....	.....	8.60	12.40	a 3.19	.....
14	Schermerhorn Bros. Co., St. Louis, Mo	.....	.....	.....	.....	.....	.....	.....	10.07
15	Henry B. Newhall, New York, N. Y	.....	.....	.....	.....	b 12.50 c 7.75	b .15 c 9.75	.....	9.75
16	American Steel and Wire Co., Chicago, Ill	6.08	4.96	5.25	.....	22.54	27.05	.....	.....

a Accepted. *b* Crosby clip. *c* As per blue print, rejected.

NOTE.—Bids for stone on "contractor's barges" at Hopefield Bend and Helena and on "Government barges at quarries" not accepted, it being more economical and advantageous to supply stone for use at Helena and Hopefield Bend from stone delivered on "Government barges at Memphis."

Abstract of proposals for levee work in Lower St. Francis and White River Leve received in response to public notice dated July 15, 1899, and opened July 2 Capt. E. Eveleth Winslow, Corps of Engineers.

No.	Name and address of bidder	Lower St. Francis Levee district.		White Rive tri
		Loop at Point Pleasant, cubic yard.	Loop at Caruthersville, cubic yard.	Station 1⅛ to ⅛, cubic yard.
		Cents.	*Cents.*	*Cents.*
1	John T. Hillsman, Memphis, Tenn		13.50	
2	T. Mike, Greenville, Miss	a 12	a 11.50	
3	Thomas Bros., Memphis, Tenn			b 27
4	Martin Jennings, Memphis, Tenn			b 28

a Accepted. b Rejected.

Abstract of proposals for levee work in White River Levee district, received in r public notice dated August 21, 1899, and opened August 31, 1899, by Capt. Winslow, Corps of Engineers.

No.	Name and address of bidder.	Station 1⅛ to 1⅛, cubic yards.	Station 1⅛ to ⅛, cubic yards.	Station 1⅛ to ⅛, cubic yard.
				Cents.
1	J. K. Beith, Knowltons, Ark			a 22

a Accepted.

Abstract of proposals for levee work in White River Levee district, received in r public notice dated September 28, 1899, and opened October 7, 1899, by Cap leth Winslow, Corps of Engineers.

No.	Name and address of bidder.	Station 1⅛ to 1⅛, cubic yard.	Station 1⅛ to ⅛, cubic yard.
		Cents.	*Cents.*
1	William Straub, Helena, Ark	a 22.95	a 22.95
2	E. B. Mantle, Avenue, Ark		

a Accepted.

Abstract of proposals for levee work in Lower St. Francis Levee district, received i to public notice dated February 5, 1900, and opened February 7, 1900, by Eveleth Winslow, Corps of Engineers.

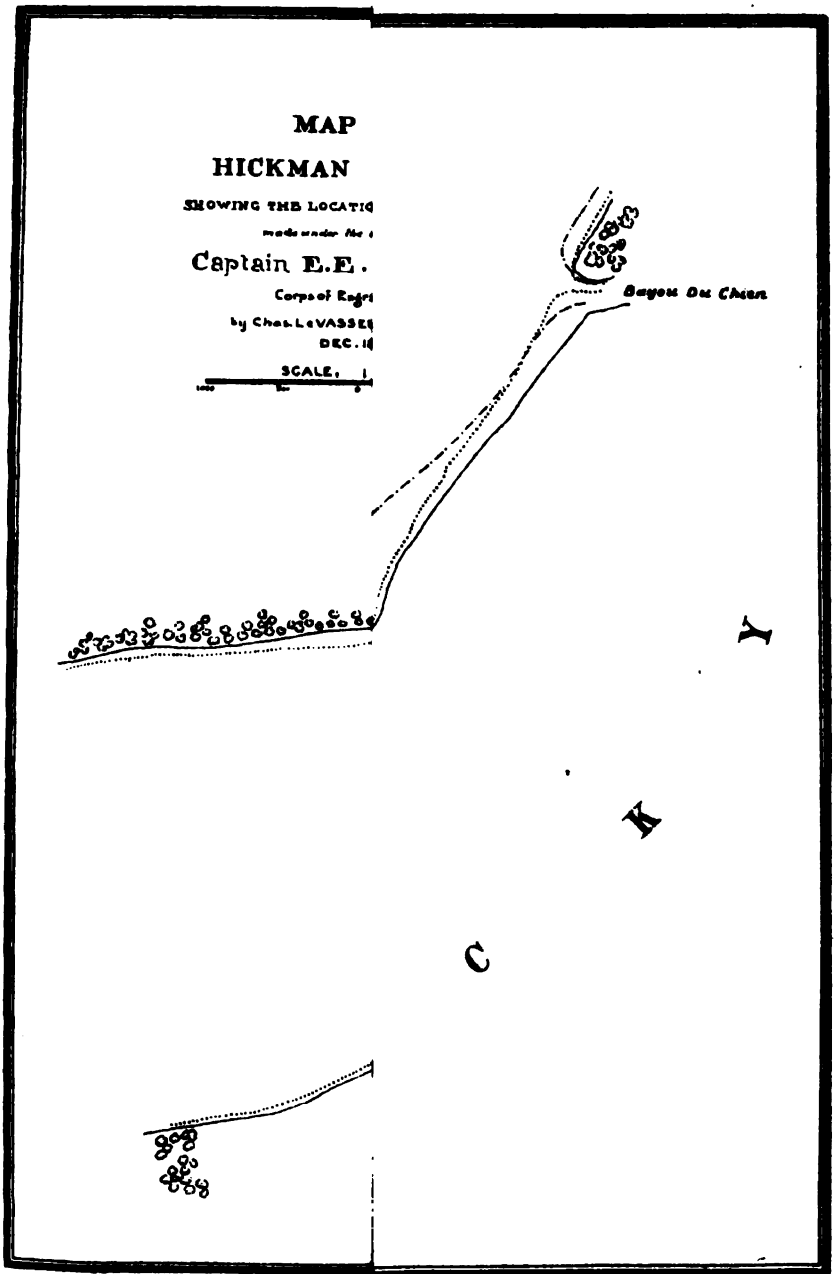
No.	Name and address of bidder.
1	Ben Talley, Memphis, Tenn
2	T. Mike, Memphis, Tenn
3	J. H. Cary, Memphis, Tenn

a Accepted.

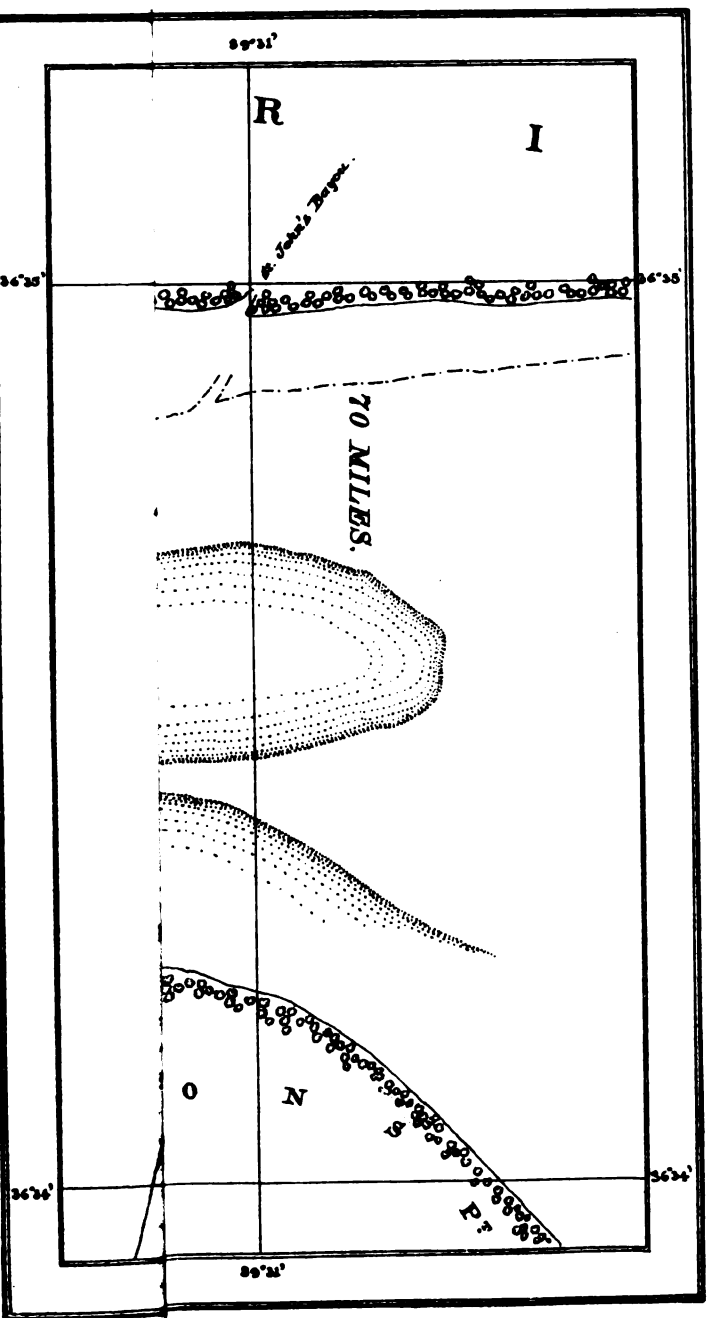
Abstract of proposals for levee work in White River Levee district, received in r public notice dated February 1, 1900, and opened February 9, 1900, by Cap leth Winslow, Corps of Engineers.

No.	Name and address of bidder.	Westover, sections 13 and 14, cubic yard.
		Cents.
1	H. Morgan, Dawsons Landing, Ark	
2	Thomas Bros., Helena, Ark	a 14½

a Accepted.


MAP
HICKMAN
SHOWING THE LOCATIO
Captain E.E.
Corps of Engr
by Chas. LeVASSE
DEC. 1
SCALE,
Bayou Du Chien
Y
K
C

Eng 56 2



Eng 56 2

ER'S LOG
A SHPO

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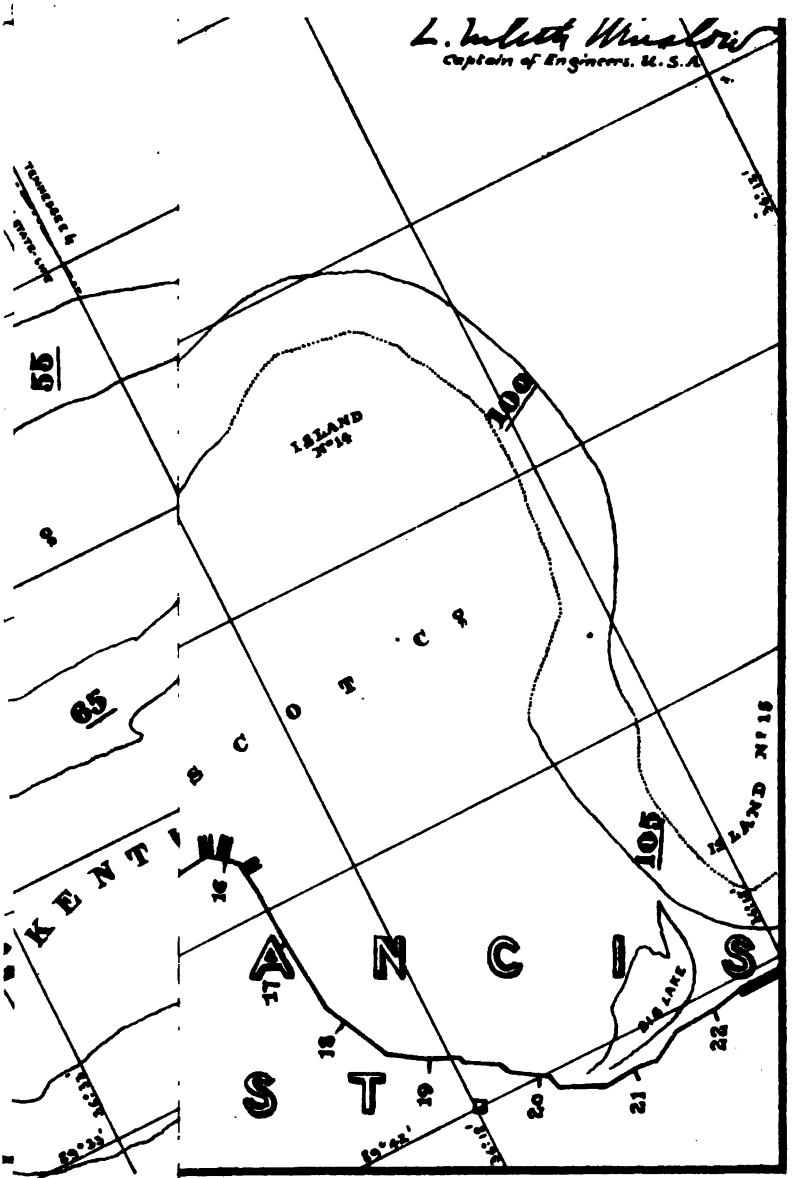
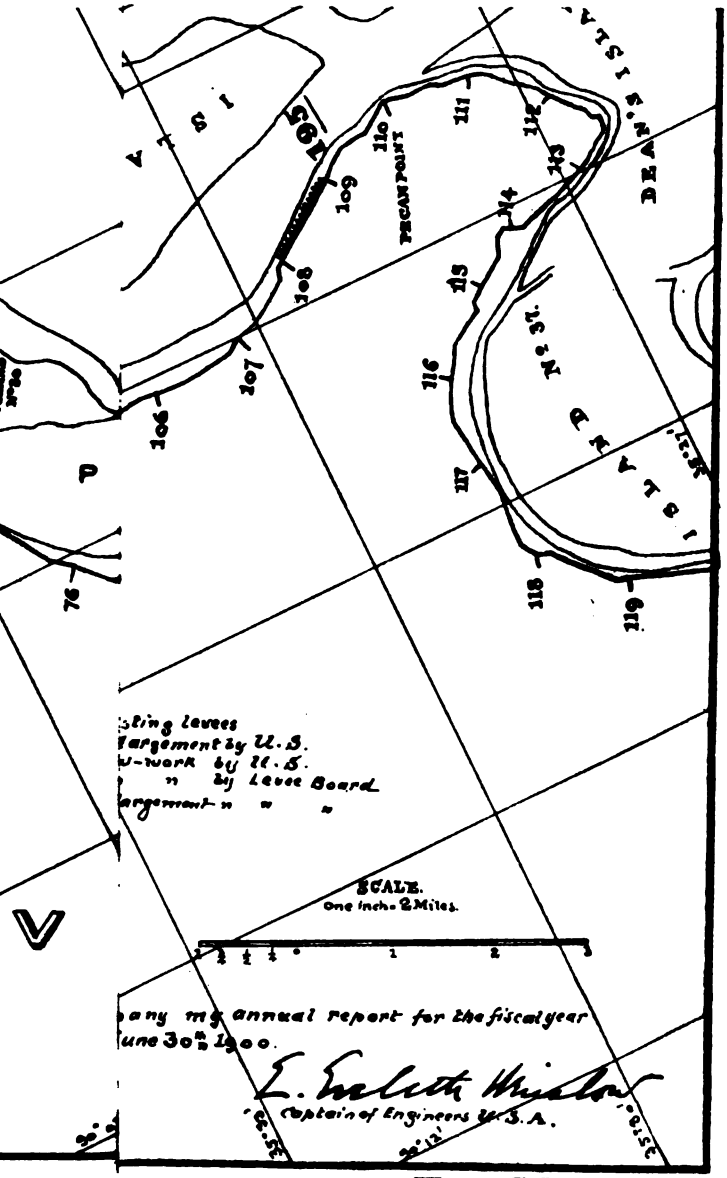
OW,

To accompany my annual report for the fiscal year ending June 30. 1900.

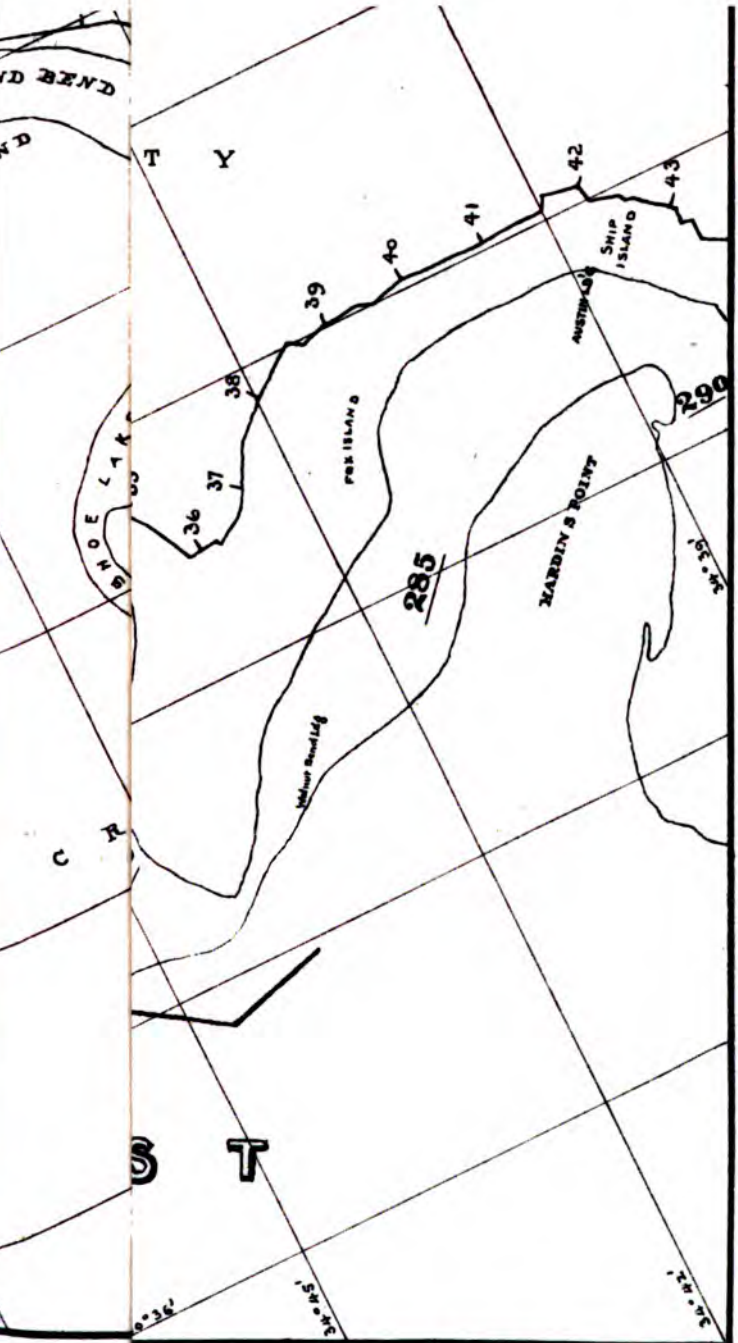
E. Enfield Winslow
Captain of Engrs. U. S. A.


L. Lalett Whistler
Captain of Engineers, U. S. A.
ISLAND
N° 18
55
65
100
105
SCOTCH
KENT
ISLAND N° 18
17
18
19
20
21
22
STANCIS
BAR LANDS
39°33'
39°32'

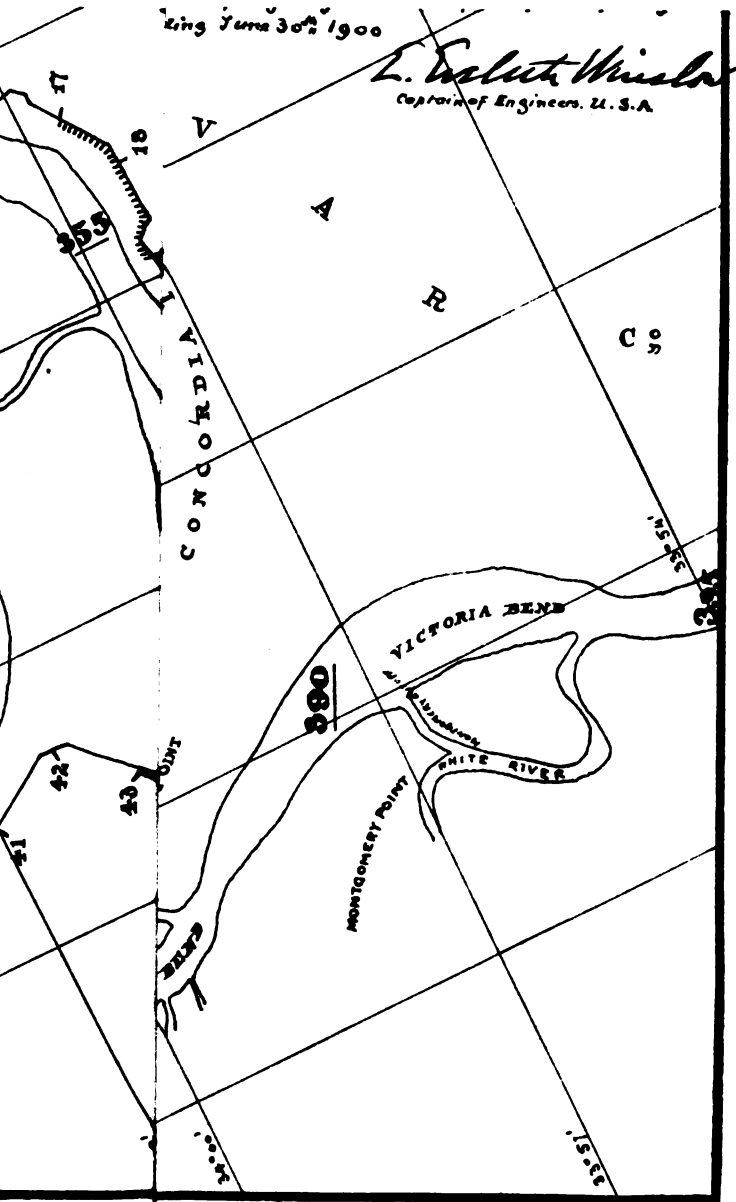
Eng 56 2


Pecan Point
No 2 St.
Dean's Island
SCALE.
One inch = 2 Miles.
existing Levees
Enlargement by U.S.
New work by U.S.
" by Levee Board
Enlargement " "
any my annual report for the fiscal year
June 30th 1900.
L. Lalith Wheeler
Captain of Engineers U.S.A.

Eng 56 2


T Y
42
43
41
40
39
38
37
36
SHIP ISLAND
FOX ISLAND
290
285
HARDIN'S POINT
S T

Eng 56 2


ing June 30th 1900
L. Talcott Miesler
Captain of Engineers. U.S.A.
CONCORDIA
PARISH
VICTORIA BEND
WHITE RIVER
MONTGOMERY POINT
360
33°51'
33°51'

Eng 56 2

ivilian engineers employed on work of river and harbor improvement, first and districts, improving Mississippi River, in charge of Capt. E. Ereleth Winslow, of Engineers, from May 1, 1899, to April 30, 1900.

address.	Time employed.	Compensation per month.	Where employed.	Work on which employed.
	Months.			
es, Mem-nn.	12	$250	Memphis, Tenn.....	Principal office assistant; preparing plans, specifications, estimates, etc.; in charge of construction works at Memphis, Tenn., Hopefield Bend, Ark., Helena, Ark., New Madrid, Mo., and Hickman, Ky.
ty, Mem-nn.	12	175	Memphis, Tenn., and various points on Mississippi River.	Care and repair of plant; in charge of construction works on Plum Point Reach and at Caruthersville, Mo.
Vasseur, is, Tenn.	8 9	150 165	Memphis, Tenn.....	Surveys and examinations; draftsman and computer in office, and dredging in Wolf River, Tennessee.
lpatrick, is, Tenn.	12	165	.....do	In charge of levee construction in Upper and Lower St. Francis Levee districts.
er, Mem-nn.	12	140	Friars Point, Miss	In charge of levee construction in Upper Yazoo Levee district.
ris, Hele-	12	140	Helena, Ark	In charge of levee construction in White River Levee district.

FINANCIAL STATEMENT.

Improving Mississippi River, First and Second districts.

, 1899.	Balance unexpended		$652,166.27
, 1900.	Amount allotted since last statement		14,000.00
1899.	Amount refunded account of disallowance in voucher 37, Abstract L, July, 1899		.40
1899.	Amount received account proceeds of Government property		130.75
1900.	Amount refunded account error in voucher 3, Abstract F, October 1899		.10
, 1900.	Amount received from B. F. Dame for rent of island in Mississippi River near Australia, Miss., for year 1900.		1.00
			666,298.52
, 1900.	Amount expended from July 1, 1899 to date.....		581,978.09
, 1899.	Amount deposited to credit of Treasurer United States, account of proceeds Government property		130.75
, 1899.	Amount of Treasury settlement, No. 9001		.20
, 1899.	Amount of Treasury settlement, No. 9030		.45
, 1899.	Amount of Treasury settlement, No. 9050		.35
, 1899.	Amount of Treasury settlement, No. 9058		1.41
, 1900.	Amount deposited to credit of Treasurer United States on account of rent of island in Mississippi River near Australia, Miss., for year 1900		1.00
			582,112.25
, 1900.	Balance unexpended		84,186.27
	Outstanding liabilities	$2,383.26	
	Amount covered by uncompleted contracts .	26,187.93	
			28,571.19
	Balance available.....		55,615.08

t that can be profitably expended during the fiscal year ending 30, 1902 ..... 1,000,000.00

itted in compliance with requirements of sections 2 of the river and harbor 1866 and 1867 and of the sundry civil act of June 4, 1897.

APPENDIX 4.

REPORT OF CAPT. CHAS. L. POTTER, CORPS OF ENGINEERS, UPON OPERATIO
THIRD DISTRICT.

UNITED STATES ENGINEER OFFI
Memphis, Tenn., May 2

COLONEL: I have the honor to submit the following report of operations in
district, improving Mississippi River, from May 1, 1899, to May 1, 1900. Th
was under the charge of Capt. H. C. Newcomer, Corps of Engineers, until
30, 1899, when he was relieved by me.

The Third district extends from the Coahoma-Bolivar County line on the
(365 L.) and the mouth of the White River on the right bank (393 R.) to th
of Warrenton, Miss. (607 L.). In its improvement works of bank protec
been executed at Lake Bolivar Front, Ashbrook Neck, Greenville Harbor, L
idence, and Delta Point; the systematic improvement of Lake Providence
attempted, and levees have been constructed and enlarged in the Upper T
Lower Yazoo Levee districts. All of these localities are shown on the acco
map of the Third district.

The operations of the past year have included repairs to the revetmen
brook Neck, Greenville, and Delta Point; repairs and extension of revetmer
Providence; the construction and maintenance of levees; towing stone, b
poles; the construction of 12 stone and brush barges and 2 mat barges, an
of plant.

LAKE BOLIVAR FRONT (417 MILES BELOW CAIRO).

The revetment at this place was built to hold a bank whose caving end
large levee across the head of Lake Bolivar. About 4,250 linear feet of revetı
constructed in 1888–89, and repairs were made in 1889, 1892, and 1893.
the work are given in the Annual Reports of 1889, page 2704; 1890, page 3
page 3752, and 1894, page 2919. Maps accompany the Reports of 1889 and

No work has been done since 1894. The revetment has been protected
by the making down of a bar from the lower point of Island No. 76, but th
been cut away during the past year, and a deposit which had been form
revetment removed, so as to expose the latter near the upper end. An ex
of this work made just as the river was rising in January indicated that th
be a break in the revetment at a point near the upper end. There are
small breaks in the upper bank paving, caused by the high water of 1897,
have not materially changed since that time. It is possible, though scar
able, that when the river falls enough to permit a careful inspection, the
may be found such as to call for a small amount of repair work. With th
tions, the revetment is in good condition for a length of 3,775 feet. The tota
tures under this allotment have been $145,358.04.

ASHBROOK NECK (446 MILES BELOW CAIRO).

The revetment at this place (see accompanying map of Ashbrook Neck)
to prevent a threatened cut-off, the minimum distance across the neck ha
reduced to about 2,000 feet. About 2,820 linear feet of revetment were c
in 1890–91, 4,300 feet in 1891–92, 2,610 feet in 1892–93, 1,475 feet in 18
repairs, principally to upper bank paving, were made in 1893–94 and 18
levee 7,300 feet long was built along the axis of the neck in 1891–92 to pre
across the neck, but it was destroyed in the next flood. In 1899 an at
made to repair two small breaks occurring during the previous high water
25 and 105. A pocket mat was sunk in January, 1899, at the latter break,
in the river prevented further work at this point. Details of the work ar
the Annual Reports of 1891, page 3639; 1892, page 3170; 1893, page 3752;
2920; 1895, page 3805; 1898, page 3370, and 1899, page 3537. Maps accon
reports of 1892 and 1893.

approved project contemplated repairing the breaks appearing after the high of 1898 at ranges 25 and 105, at a cost of $8,250, and providing a reserve supply 00 cubic yards of stone from the Government quarry on Little Red River, at a about $15,000. When the low water came it appeared that much more repair vas necessary, calling for mats to the extent of 4,457 squares and paving to ent of 1,081 sqares, all of which has been done during the last year. This d the available funds to a little over $7,000, and, owing to the fact that con- le plant would be required to open the quarry, and that it was too late in the to get the stone out during this high water, the reserve stone was not pro- except about 900 cubic yards left on the bank when the season's work was For details of this work see report of Mr. Arthur Hider, appended.

revetment covers a distance of nearly 10,000 feet, and is in fair condition, but obably need some repairs during the coming season, and may require an exten- river, as there is caving above the present line of revetment which indicates ing of the latter. The total expenditures on this work since the last Annual have been $35,803.66, and under the whole allotment have been $482,773.56.

GREENVILLE HARBOR (478 MILES BELOW CAIRO).

revetment at this place (see accompanying map of Greenville Harbor) was protect the town of Greenville, which was rapidly caving into the river when rk began, in 1887. The first project was to hold the bank with submerged spur onsisting of cribs resting on foundation mats. In 1887, 1888, and 1889 twelve ces were built, and one longitudinal pile dike, and mats were placed between f the spur dikes. Caving continued, however, in the bend above, and during od of 1891 the upper dikes were flanked, four spur dikes and the longitudinal ing carried away. The revetment of the bank above the remaining dikes was egun, 6,600 linear feet being built in 1891–92, 4,450 feet in 1892–93, and 3,087 1894–95, woven mats being used in all this work. Repairs were made to upper- aving in 1893 and 1894. In the flood of 1894 the upper remaining spur dike rried away, leaving seven spur dikes still in position. Breaks in the revetment epaired by the construction of about 677 linear feet of new revetment in 1896, ascine mats, and 1,850 feet in 1897–98, together with considerable new upper- ork. In 1899 extensive repairs were made by sinking 5,108 linear feet (14,666) of channel mat and ten pocket mats, amounting to about 2,843 squares, and 5,882 squares of bank. Three small dikes were also built to prevent wash on he bank which threatened to flank the line.

details of the above operations are given in the Annual Reports of 1888, page 889, page 2706; 1890, page 3240; 1892, page 3173; 1893, page 3753; 1894, page 895, page 3805; 1897, page 3726; 1898, page 3270, and 1899, page 3538. Maps any the reports of 1888, 1889, 1890, 1892, 1893, and 1899.

first of last year's projects contemplated repairing the revetment work at the end, at a cost of $9,000, and of the upper-bank paving, where needed, at a cost 00, providing a reserve supply of 10,000 cubic yards of stone on the bank, at a $15,000; repairing the plant, at a cost of $10,500, and constructing two new nd stone barges and two new mat barges, at a cost of $14,500.

ond project was submitted on June 14, 1899, and afterwards approved, for eet of channel mat and 200 feet of complete revetment, at a cost of $26,000. the season the revetment work at the upper end (range 102) was done, the allowed for in the second project (range 136) was repaired, and also a small nal break at range 60. The two mat barges have been completed and paid for

The two brush and stone barges have been completed and paid for, except cent retained until completion of contract. The repairs at Ashbrook Neck were ered of more importance than the 1,600 feet of channel mat at Greenville, and he former work was finished the water was too high for the latter and it was er until the next season. Owing to the short time available for quarrying t the Government quarry and towing out during the high-water season it t thought practicable to undertake to provide a reserve supply of stone this but arrangement was made with the parties contracting for the barges to at Greenville the last five of their contract loaded with stone, which will give reserve of about 1,667 cubic yards. For details of this work see report of Mr. Hider, appended.

length of revetment work at this place is about 11,600 feet, and about 2,900 feet ected by the dikes below. The total expenditures on this work since the last l Report have been $44,146.78 and under the whole allotment $843,418.02, not ng $42,277.10 contributed in 1887 by the town of Greenville.

LAKE PROVIDENCE REACH (517 TO 552 MILES BELOW CA

Earlier works.—This was one of the reaches first selected by the Commission for systematic treatment. The least low-water depth before its improvement was undertaken are variously reported as 4 original project provided for giving the low-water channel an appr width of 3,000 feet by constructing contraction works, closing al holding the caving banks. Instead of covering the entire reach ever, as originally intended, the works as built were confined to 20 miles, from 522 to 542 miles below Cairo. Operations were b actively prosecuted until 1885, and some repairs were made to thes 1886 and 1888–89. The Duncansby, Mayersville, Baleshed, and Sta of dikes were constructed on the Mississippi side of the channel an and Elton systems on the Louisiana side, and bank revetment w Louisiana Bend and Mayersville Island. The total lengths of the tions were about as follows: 112,396 feet of pile dikes, 48,238 feet of dikes, 16,547 feet of foot mats along the dikes, 5,588 feet of scree dikes, 13,561 feet of wattling between dikes, 520 feet of shore reve of dikes, and 33,476 feet of bank revetment. See Annual Report o for a tabular summary of the work. The details of these works Annual Reports of 1883, page 2285; 1884, page 2814, and 1885, pag Maps accompany the reports of 1883, 1884, 1888, and 1889.

These earlier works had a beneficial effect on the channel, but th tively weak and were lost, partly through lack of funds for their Congressional limitation of the use of bank revetment. The Dunc reported as practically destroyed by 1886, the Louisiana Bend revetm by 1889 only portions of the system at Baleshed Bar and Stack Isl of all the works that had been built. Parts of these are still in exi exposed to the destructive action of the river.

Louisiana Bend revetment (522 R.).—In 1889 active work was decided to revet the caving bank near the head of the reach in Louisi thus to give greater permanence to the channel throughout the rea linear feet of revetment were built in 1889–90, 5,224 feet in 1891–92 1892–93, when further operations were suspended awaiting the rest ments with dredging. The type of revetment used was much stron merly employed, consisting of woven mats below water, 260 to 3 upper-bank paving of stone 10 inches thick. On account of the u the bank along the mouth of Old River it was necessary to make year to the upper-bank paving, where sloughs occurred during low in 1892 and 1893 seven short spur dikes of brush and stone were b bank where the high waters caused scouring behind the revetmen revetment were repaired in 1896–97 by the construction of about 1 new revetment, using fascine mats. The details of these operations Annual Reports of 1890, page 3229; 1892, page 3177; 1893, page 3754 1895, page 3806; 1896, page 3653, and 1897, page 3727. Maps accon of 1890, 1892, 1893, and 1896.

After the flood of 1897 a number of breaks appeared between ra Thorough repairs would have required the practical renewal of t revetment. In view of the small amount of available funds and t had been experienced in holding this part of the bank, it was de this part of the work for the present.

No work of construction has been done here during the year, an mended. The length of revetment, including the above breaks, is measured along the shore edge of mats.

Lake Providence revetment (540 R.).—This revetment (see accon revetment at Lake Providence) was built to hold a rapidly caving ened to destroy the town of Lake Providence and the important lev of the lake. About 4,780 linear feet of revetment were built in 1 in 1895–96, and repairs to upper-bank paving were made in 1898. work was begun to extend the revetment a short distance up river, two small mats the river rose, and work was suspended. The de are given in the Annual Reports of 1895, page 3806; 1896, page 3653 and 1899, page 3540. A map of the work accompanies the report o

A revised project was submitted on June 14, 1899, and approve extending the revetment up river as far as available funds ($60,00 which was thought to be about 2,000 feet. When the river fell, found that repairs to the existing work were necessary near the u

), and also at a break at range 19, the result being that the revetment has been
ed up river about 1,200 feet only in the last two years, and practically all of
ds have been expended. For details of this work see report of Mr. Arthur
appended.
the completion of this season's work, the upper-bank paving has been
d and washed away for about 50 feet at the upper end, and for a short dis-
t range 106, while the bank for some distance above the revetment is caving
the point of greatest danger now being the lower end of the New Elton Loop.
gth of this revetment work is now about 11,000 feet, and, with the exceptions
numerated, is all apparently in good shape.
ollowing table gives the least depths reported on crossings in Lake Provi-
Reach for the different years:

Date.	Crossing.	Depth on crossing.	Reading of Lake Providence gauge.
		Feet.	
	Stack Island	5	0.55
884	do	10	8.9
885	Ben Lomond	13	7.1
886	Stack Island	8.5	4.7
887	do	7	4.5
888	do	9	5.75
889	Ajax Bar	7	2.25
		11	8.5
		7	10
892	Ajax Bar	5.5	1
896	Wilsons Point	12	1.6
897	do	7	—2.2
8	do	9	7.8
899	Baleshed	10.5	—0.5

-Extreme low-water depths of 6 to 7 feet have been reported for the years 1893–1895.

otal expenditures for the reach have been $3,609,043.67.

DELTA POINT (598 MILES BELOW CAIRO).

ut-off that occurred at Vicksburg in 1876, and the subsequent shoaling of the
leading from the river to the resulting lake front of the city, practically
ed the harbor of Vicksburg for low-water commerce.
irst operations undertaken for the improvement of the harbor consisted in
g the rapidly caving bank at Delta Point, as its continued recession was
ng the distance from the harbor proper to the channel of the river. From
1881, before the Mississippi River Commission assumed charge of the work,
ere built about 5,400 linear feet of revetment, one mattress spur dike, and
een dikes, at a total cost of $203,229.87. The details of the work for this
period are found in the Annual Reports of 1878, page 637; 1879, page 974; 1880,
33; 1881, page 1384, and 1882, page 1502.
river and harbor act of August 2, 1882, placed this work under the super-
f the Mississippi River Commission. The work of revetment at Delta Point
ntinued, 1,100 linear feet of revetment being built in the season of 1882–83,
et in 1883–84, 2,083 feet in 1884–85, 1,065 feet in 1893–94, and repairs to upper-
aving were made in 1898. On account of unfavorable season for work the
for 1898 was not carried out, but left to go over to 1899. Practically all the
rior to 1882 is destroyed or covered by the later work. Only the mats of
had the present standard width of 300 feet, the earlier ones being from 150
eet wide. Details of the work under the Commission are given in the Annual
of 1883, page 2290; 1884, page 2820; 1885, pages 2787 and 2964; 1889, page
393, page 3754; 1894, page 2921, and 1898, page 3373. Maps accompany the
of 1883, 1884, 1888, 1889, and 1893.
pproved project for the expenditure of about $40,000 contemplated repairs to
revetment for a distance of about 900 feet upstream and 800 feet downstream
e work of 1893–94, which work was in good condition but was being flanked
ends, owing to the fact that the old revetment had practically disappeared at
oints. Three pocket mats were constructed in the pocket below the work of
and the bank graded and paved opposite these mats. A channel mat 716 feet
d 300 feet wide was sunk above the work of 1893–94 and the bank graded and
pposite this mat and down about 200 feet along the older work.

For details of this work see map of Delta Point and report of Mr. Arth appended.

A recent examination shows a deep pocket forming above this year's wo ening to cut around its head unless soon protected. The old work farther river has been generally silted over, and the only danger appearing at pre the point mentioned.

The improvement of Vicksburg Harbor proper is now in charge of the Department, in accordance with the project adopted by the river and har July 13, 1892, providing for the diversion of the Yazoo River into Centen A summary of the work done in the harbor by the Mississippi River Com given in the Annual Report of 1897, page 3728.

The total amount expended under the Mississippi River Commission $442,724.75 in Vicksburg Harbor, and $186,255.68 at Delta Point, making expenditures at the latter point $389,485.55.

LOWER YAZOO LEVEE DISTRICT (365 TO 592 MILES BELOW CAIRO).

This district extends in Mississippi from the Coahoma-Bolivar County li mouth of the Yazoo River, being practically coterminous with the local l levee district.

The levee line is continuous from the upper end of the district to Kigers Lake. Its length is about 188.14 miles, covering about 220 miles of the ri

During the past year there have been added to the line by the United St 1,850,200 cubic yards, and by the local board about 1,068,576 cubic yards portion of the revenues of the local levee board is expended for rights o damages to property affected by levee work. The net contents of the li 1900, are about 28,832,426 cubic yards. The United States have built about 15,799,468 cubic yards. Tabular statements of expenditures and wor the United States accompany this report.

It is estimated that about 2,580,000 cubic yards of earthwork will be r bring the levees of this district to the provisional grade of 3 feet abov water of 1897, or about 17,845,000 cubic yards for the ultimate grade adopt Commission, which averages about 5.4 feet above the high water of 1897.

The Commission allotted $247,000 for work in this district, and on Jul 1,029,000 cubic yards were let at an average cost of 16.2 cents per cubic ya the exception of one banquette work, which went for 14.99 cents, the whol enlargement and topping. Including the 22 works incomplete at the ti last annual report, there have been 40 works under agreement for const the past year, and all have been completed. The season has been very fa levee work, which accounts for the completed condition of all these works

No high-water work has been necessary during the year, as the river ha out of its natural banks.

On a large portion of the new work and on some of the older work t failed to grow, or had been killed, and all of these portions have been, or few days, resodded by hired labor.

For additional details of work in this district see report of Mr. H. St. appended.

The total expenditures for levees in the Lower Yazoo district made by States have been $2,788,132.68.

UPPER TENSAS LEVEE DISTRICT (402 TO 606 MILES BELOW CAIRO)

This district extends from the Arkansas River to a point in Louisia Warrenton, Miss. There is a continuous levee line about 171.66 miles lo ing from Costello's gin, on Amos Bayou, along that bayou and Cypress C Mississippi River (13 miles), and thence along the river to the lower district (157.1 miles).

The district is protected from overflow of the Arkansas River by a levee that river from the vicinity of Pine Bluff to the foot of Lake Jefferson. Bluff to Red Fork (57.3 miles) this line is of comparatively weak section hitherto maintained by the local authorities. From Red Fork to the fo Jefferson (12.4 miles) the line was built in 1894–96 by the United Stat standard section of 8-foot crown and slopes of 1 on 3. During the pas levee has been topped to 2.5 feet above the high water of 1897 by the Un and extended 1.48 miles, the latter being paid for by the United States levee boards combined.

During the past year there have been added to the line by the United S 1,553,373 cubic yards, and by the local authorities about 784,882 cubic ya

nount, 364,564 cubic yards in Arkansas and 420,318 in Louisiana, and of the 328,134 cubic yards in Arkansas and 725,239 in Louisiana. The length of wn out by the construction of new loops was 12,418 feet, containing about cubic yards, thus giving total contents of levees May 1, 1900, about 26,785,610 rds. The United States have built altogether about 19,835,789 cubic yards. statements of expenditures and work done by the United States accompany rt.

stimated that it will require, after the completion of existing contracts, about 3 cubic yards to bring both levee systems in this district to the provisional 3 feet above the high water of 1897, without extension of the Arkansas River or any changes in the present line, or about 19,867,682 cubic yards for the grade adopted by the Commission, which averages about 5.5 feet above the ter of 1897. To close the gap between Lake Jefferson and Cypress Creek, ng the two systems, will require for the 3-foot grade 1,508,412 cubic yards, the Commission grade 2,328,960 cubic yards.

829,000 cubic yards of work have been let in this district during the year, at price of 18.62 cents per cubic yard, under allotments aggregating $197,600. k was new levee, which went at 13.75 cents per cubic yard, and all of the either enlargement or topping. Including the 26 works remaining unfin- lay 1, 1899, there were 37 pieces of work under agreement for construction he year. Of this number two remain incomplete, covering about 103,000 rds, of which about 52,000 cubic yards are still to be done.

were no high-water operations in this district during the year.

ovember and December, 1899, a survey was made on lines connecting the s River and Mississippi River systems, and estimates made of the yardage y to build the different lines. (See accompanying map.)

any cases of new work and on some of the older work the sodding either live or was killed, and most of this has been or will be resodded.

dditional details of work in this district see report of Mr. E. C. Tollinger, d.

otal expenditures by the United States for levees in this district have been 62.30.

SURVEYS, GAUGES, AND OBSERVATIONS.

ys were made of Carters Neck and Caulks Neck to determine the rate of and complete surveys were made of the different revetments throughout the in September and October, 1899. A survey was also made of the Bee Rock on Little Red River, owned by the United States, in April, 1900 (see accom- map), and an estimate made of the plant necessary to properly work the The results of these surveys were platted and maps made. Additional details en in the report of Assistant Engineer Arthur Hider, appended. The total itures under this allotment have been $75,875.44.

STONE.

contracts were made for stone—one, loaded on barges at Arkansas City, for r cubic yard; one, loaded on barges at Greenville, for $1.75 per cubic yard, e, loaded on barges below Vicksburg, for $1.60. Owing to the fact that the s of this valley is mostly done at about the time the river gets low enough for ent work, the railroads are unable to furnish cars to the stone contractors enough to keep the work going. Mr. George C. Thomas, superintendent of ction, estimates in his report on the survey of the quarry owned by the United hat stone can be quarried, towed to Greenville, stored on the bank, and d on barges for $1.33 per cubic yard. Considering these facts, and the addi- fact that towing must be done at a season when the fleet will otherwise be le, the advantages of quarrying and storing stone are very evident.

otal expenditures under this allotment have been $190,000.

PLANT.

irs to plant were made during the year as shown in the detailed statement anying the report of Mr. Hider. The cost of repairs amounted to $19,383.09, cost of caring for the floating plant and other property amounted to $20,263.59. new brush and stone barges have been built by John Barrett & Son, of Cin- and all have been delivered to the Government except five, which will be ed in a few days.

The total expenditures under this allotment have been $729,34
The following papers and maps accompany this report:
Report of Mr. Hider on surveys, revetment work, stone, and p
Report of Mr. Coppee on levees in Lower Yazoo district.
Report of Mr. Tollinger on levees in Upper Tensas district.
Tables showing cost of work done by the United States on leve
Map of Third district.
Maps of revetments at Greenville Harbor, Ashbrook Neck, La
Delta Point, a map showing result of surveys connecting Arkans
Mississippi River levees in Upper Tensas district, and map of qu
United States.
The list of civilian engineers, abstracts of proposals, and finan
be forwarded on or about July 1. There are no unfinished c
this district.

Very respectfully, your obedient servant,

CHA
Captain,

To Col. G. L. GILLESPIE,
Corps of Engineers, U. S. A., President Mississippi River Com

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REPORT OF MR. ARTHUR HIDER, ASSISTANT ENGINE

GREENVILLE, M

SIR: I have the honor to submit the following report of surveys
repairs to plant and care of same, from May 1, 1899, to May 1, 19

SURVEYS.

A party was organized and left Greenville on September 5, to
the different revetments in advance of the repair work and exte
the season.

The party was in charge of Mr. L. Y. Kerr, surveyor, as chie
sisted of chief, four assistants, and the necessary laborers. Th
and a quarter boat were used to transport the party. The field w
October 19, the party returned to Greenville on October 20, and
the fleet. The platting and maps were finished October 25.

The expense of the survey was as follows:

For salaries and wages.....
Subsistence .....
Material and supplies.....

The field work consisted of soundings over the following revetm
Ashbrook Neck, Greenville Harbor, Louisiana Bend, Lake Pro
Point. Shore lines were located on the upper side of Caulk
Neck.

The office work consisted in platting these surveys. The fo
made:

1 index map and 4 sheets sections, Lake Bolivar Front.
1 index map and 5 sheets sections, Ashbrook Neck.
1 index map and 11 sheets sections, Greenville Harbor.
1 index map and 5 sheets sections, Louisiana Bend.
1 index map and 6 sheets sections, Lake Providence.
1 index map and 4 sheets sections, Delta Point.
1 map, Caulks Neck.
1 map, Carters Neck.
Total, 8 maps and 35 sheets of sections.

The condition of the different revetments as shown by these su
reported by Mr. Kerr, was as follows:

Bolivar Front revetment.—Ranges 4+78 to 5+05, inclusive, acro
Island 76, were entirely out of water. The bed of the chute
erally, to admit of levels being run over the ranges, they were

and 5+05. The sections show that there has been a very heavy deposit ranges 3 + 94 to 10+58, and that it has again caved and scoured out.
e low-water channel has recently changed to this front, striking in just above 6+05 and reaching the main bank just below range 10+58. The caving in eposit is shown by the abrupt changes in the sections, and is also indicated on dex map.
ere has been a general scour from range 10+58, decreasing in depth, to range 5, where it is only very light. From range 31+24 to 6+28 there has been a heavy deposit, amounting to as much as 15 feet on the latter range. The chan- this point is very narrow and the current very rapid. There has been slight ning of the upper slope on ranges 3+20 to 6+28, inclusive.
s not apparent that the revetment is in any immediate danger.
brook Neck revetment.—The sections show more or less scour through the mat- over the entire work. From range 150, at the upper end, to range 135, the scour een general. From ranges 134 to 99 it has been on the inner half of the mat n. From range 94 to the lower end it is again general. Ranges 122, 123, and ow the effect of the slough in the upper slope. At range 108 there is a slough 100 feet in length, which extends up the slope about 10 feet above the zero of uge.
range 106 there is a recent cave on the upper side of the pocket that was repaired eason. Section 105 shows the result of last season's repair work, and apparently derable scour through the mattress, due, probably, to eddy action.
tions 97 and 96 show the result of a recent cave. Sections 22, 24, and 26 show er developments of the slough reported on range 26 last season. About the amount of caving has taken place above and below the work.
enville Harbor.—The caving in the bend above the work was about the same as g previous years. The hole behind the revetment at the head of the work has ded down to range 103. Range 97 is the first one crossing the mattress work, n this there is considerable fill over the inner edge of the mattress. On sec- 98, 99, and 100 there is considerable scour at the inner edge of the mattress on vo former and on the outer edge on the latter. It is my opinion, however, that attress is adjusting itself to the new conditions and is in fairly good condition; wise, this submerged ridge would not so nearly maintain its original shape such radical changes were taking place immediately behind. Section 104 s a slight scour on the upper slope. Sections 110 to 113 show changes on the slope due to grading during last season's work. Sections 133 to 138 show considerable scour. A slough has occurred in the upper slope between ranges nd 138, the extent of which is shown on sections 136 and 137. The changes on nner half of sections 139 and 140 were caused by a slough, and the subsequent ring, which occurred after the revetment survey was made last season.
tions 5 to 24 and 43 to 47 show changes on the upper slope due to grading. or less scour through the mattress has occurred from ranges 20 to 41, being heavy on ranges 21 to 24. Sections 61 and 62 show very heavy scour on the portion, 68 to 71 considerable scour through mattress. The zero line of the as moved slightly toward shore.
isiana Bend revetment—The upper part of this reach (ranges 62 to 76 inclusive), y surveyed, was out of water, and being a soft mud bar it was not practicable levels over the ranges, so that part was omitted.
e sections show a very heavy fill from ranges 78 to 106. On sections 100 to 106 e seen the extent of the sloughing of the upper slope. On ranges 108 to 117+ e changes are slight, with a tendency to fill. On ranges 120, 122, and 124 the bank work has been destroyed by sloughing. From range 130 to range 162, wer end of the work, the upper slope work is virtually all destroyed by caving, onsiderable scour has taken place through the mattress. The work generally, Old Red River down, is in very bad condition. Very slight changes have been in the zero line of the bar and the shore line below the work.
e Providence revetment.—Beginning at the lower end of this work and coming he first change of any consequence is found on section 70, where there has been derable deposit from ranges 70 to 94. Sections 96, 98, 100, 102, 104, 106, and now very heavy scour. The indications are that deep scouring through the edge of the mattress will cause the bank to slough out, as it has done on s 108, 112, 114, and 116. Sections 118 to 132, inclusive, are the first sections that been made of these ranges, some of which will be covered by this season's work. heavy caving has occurred in the bend above the work, and the zero line of the as moved inshore about 600 feet opposite ranges 88 to 116.
a Point revetment.—From range O east to range A, the lower end of the work, is a tendency to fill over all the ranges, with no changes of any importance.

On range O west, there is a slight inshore scour noticeable, which incr up the river, and extends out to the bed of the river on ranges 4 to 17, in ranges 29 to 39, inclusive. The extent of the caving and sloughing o slope is seen on sections 5 and 6, 17, 19, 21, 23, 25, and 27, and from 31 inclusive.

From ranges 7 to 37, there are numerous small sloughs in the upper sl not appear on the sections, and can not be shown on the index map, t show a very unstable condition of the bank generally, and that the work of great damage. Very little caving above and none below the work dur season.

The shore lines on the upper side of Caulks and Carters necks were platted on maps giving a more complete survey made by Mr. Miller in caving continues at about the same rate that it has maintained for the five years, the maximum being about 200 feet for each place. On Caull caving is moving down the bend. No surface change is perceptible on Very rapid caving is going on in Cypress bend; just above the foot of La and in the bend immediately above Salem, La.

REPAIRS AND EXTENSION OF REVETMENTS.

The original projects before beginning the season's work were:

(1) *Ashbrook Neck revetment.*—Repairs to break in revetment, 300 line work.

(2) *Greenville Harbor revetment.*—Five hundred linear feet of new wor break, and 1,600 linear feet of mattress work 250 feet wide to reenforce th ment, ranges 119 to 135.

(3) *Lake Providence revetment.*—To extend the revetment 2,000 feet farthe

(4) *Delta Point revetment.*—Repairs to the old revetment, ranges 3 to 9 extension of the revetment above range 2 west.

After the revetment surveys had been made in September and October of repairs found necessary was materially increased above the origin Faults appeared as the river fell which were not perceptible at the highe

It was deemed advisable, on account of the quantity of work to be don as it was over a distance of 200 miles, after taking into consideration t importance of the different revetments and the desirability and econom all mat work finished while the river was at low stage, to make the extensions in the following order: Lake Providence, Delta Point, Greenvi and Ashbrook Neck; the object being to do the important mattress work ing the mat party constantly employed, and following up this work wi party to grade and pave the upper bank, so as to have the entire work c advance of high water.

The aggregate amount of mattress work done at the different localities

Lake Providence	
Delta Point	
Greenville Harbor	
Ashbrook Neck	
Total	

This would be equivalent to a length of 5,046 feet of standard mat 300 addition to grading and paving the upper bank slope in front of these extensions.

LAKE PROVIDENCE REVETMENT (540 R.).

After the water had subsided within the banks, and before repairs we was found that the mattress sunk at the close of the last season during a bank-full stage to protect the upper end of this revetment had offered littl except to the upper part of the slope. Caving above this point had been a deep pocket had formed just above the work, leaving the head of the jutting out beyond the general shore line above about 600 feet. A destr action had been set up during the high stages immediately below, the effe had been to seriously injure the upper slope between ranges 106 and 108 110 and 112.

As caving was still active above the head of the revetment and the poc ually deepening, it was decided to first repair the injured part of the re the head, and after this was done to continue the revetment upstream a

would admit. The upper slope paving and mattress work above water was
ed from the point and the point graded to a flat slope, so as to make a more
l change from the alignment of the shore line above to that below over the
eted revetment, in order to destroy as much as possible the eddy action at high
It was thought that this would prevent further injury and hold the head of
rk intact.
ng the last high stage of water the eddy action was such as to destroy a con-
le portion of the upper bank slope between ranges 106 and 110 by undercut-
This should be repaired the coming season.
rations were begun early in the season. A force was organized and moved to
e of the work on July 31, and work begun August 1 in constructing the first
el mat.
dimensions of the mats built are as follows:

	Squares.
el mat No. 1, 950 by 300 feet	2,850
el mat No. 2, 530 by 250 feet	1,325
el mat No. 3, 350 by 200 feet	700
el mat No. 4, 330 by 250 feet	825
mat No. 1	374
mat No. 2	318
mat No. 3	75.5
Total	6,467.5

No. 4 was constructed between ranges 18 and 21 to cover a break in the
art of the upper bank slope that developed after the mat work at the head of
etment had been completed.
rouble was experienced in sinking any of these mats excepting No. 1. This mat
n sinking, parting first on the outside at about 75 feet from the head, while
t barge of stone was being placed in position preparatory to sinking. The
extended to within 75 feet of the shore edge of the mat, allowing the outer
double up and move downstream about 200 feet, the inner or shore edge
held in position by the shore cables. Soundings showed 600 feet of the mat
condition, covering the subaqueous slope well out to deep water, and within
0 feet of the width originally intended. The upper portion was practically of
ice. Mat No. 3 was built to cover over the damaged portion at the head.
only unusual conditions existing, aside from the fact that the trend of the
due to the configuration of the shore line in the pocket above was at an angle
t 30 degrees with the axis of the mat, was that on account of the length of
at the mat lay on the water before sinking (nearly three weeks) the upper
the mat became weighted with sediment, and a portion about 60 feet in length
0 feet in width sank, forming a bag or pocket. The excessive and unequal
t this point caused the longitudinal cables to part either before or when the
nal stress caused by sinking was added. The current was not unusually swift,
e accident was unexpected.
ling.—Hydraulic grader No. 1, with a single crew, was put in service Septem-
nd completed grading October 18. The total length of bank graded was 1,900
eet, making an average rate of progress of 45 linear feet of bank for each work-
. The bank was difficult to grade to anything like an even slope on account
ightness of the material. The grader merely got rid of the surplus material,
tating an unusual amount of work to be done with shovels, teams not being
le.
dressing.—Nineteen hundred linear feet of bank was dressed by shovels.
this head is included clearing the top of the bank of timber, stripping stone
e injured slopes, and all additional work to complete grade after the hydrau-
der.
paving.—This work was begun September 16 and finished January 1. Work
t carried on continuously, the party being transferred to Delta Point to finish
pe paving at that place during part of this time. The total number of squares
was 2,510; stone used, 3.37 cubic yards per square.

DELTA POINT REVETMENT (598 R.).

work done was the construction of three pocket mats between range 3 and
0 east, and the regrading and repaving of the slope in front of these mats,
had been badly cut into from eddy action. A channel mat was also con-
d between range 2 and range 9 west, extending the revetment 716 feet farther
m.

The mat party, after completing the mat work at the head of the La revetment, was transferred to this point on September 25, and began same day. The mat work was finished on October 27.

Mattress construction.—The dimensions of mats constructed were as fo

Channel mat No. 1, 716 by 300 feet	
Pocket mat No. 1	
Pocket mat No. 2	
Pocket mat No. 3	
Total	

Grading.—As the bank was of an unusually flat slope where the ch to be constructed, it was deemed advisable to finish the work with sl order not to disturb the old work more than was necessary the sam used on the slope in front of the pocket mats; 1,500 linear feet of bank the work being finished October 28.

Paving.—Bank paving was begun on October 4 and completed Number of squares paved, 1,830; stone used per square, 4.03 cubic yar

In order to facilitate the progress of the work and at the same time the need of barges, which were required at other points, a spur track the top of the bank contiguous to the edge, so that stone could be re and unloaded where needed. The cost of laying this spur, which long, was $306.77, the ties and iron being furnished by the contract arrangement sufficient stone was received to finish the work at a muc and at considerable less expense than it could have been done by whee up the slope from barges.

The amount of stone delivered by the Rankin Stone Company unde this work was:

On barges at Vicksburg, Miss	
On bank at Delta Point, Louisiana	
Total	

There is a reserve of about 1,000 cubic yards now on bank for future

On November 1 the mat party was moved back to Lake Providence mat between range 18 and range 21, a fault having developed in the after the party had left there.

GREENVILLE REVETMENT (478 L.).

The damage to the work at this locality consisted of two small sloughs bank, ranges 134 to 138 and ranges 60 to 63, and slight damage to the revetment, ranges 99 to 104.

During the last high water several holes had been scoured out below the ground behind the revetment between ranges 25 and 35. These we the abandoned levee in the rear.

Along this front the space between the levee and river front had been in order to obtain earth for enlargement of the levee in 1898. The s part of the distance is extremely light and offers but slight resistance to the surface soil is removed. A great part of the damage done during th of 1898 is attributed to this cause, the current destroying the revetmen out holes below the surface in the rear of the revetment and thus d upper bank slope. To prevent a repetition of this damage in the fut feasible and least expensive way that suggests itself would be to build levee and the river front a series of cross dikes of brush or earth at the points. The brush dikes placed just below the head of this work in 189 reason answered the purpose well.

The original project for these repairs was not entirely carried out. Aft were made to the breaks in the revetment, ranges 134 to 138 and ranges developed after the water fell), and the strengthening of the head of th ranges 99 to 104, had been completed, the washouts behind the revetme the exposed parts of the upper slope covered with stone, on account of of the season and the necessity of making the repairs to Ashbrook Nec the mat party was moved there and the building of 1,600 feet of chann nally proposed, ranges 119 to 137, was deferred to next season, being

nportance than thorough repairs to the Ashbrook Neck work. The party, with , after completing the Lake Providence work, arrived on November 15, work begun the same day.

tress construction.—The dimensions of mats constructed were as follows:

	Squares.
t mat No. 1, ranges 134 to 138	394.8
t mat No. 2, ranges 60 to 63	292.7
t mat No. 3, ranges 100 to 102	195.5
Total	883

eavy brush revetment was also laid over the ridge, projecting above the head e work after it had been graded down, connecting with the mat sunk in the t next to the shore, 479 squares of this revetment being built, which was well ed with stone.

e head of this revetment is now believed to be well secured from attack.

k grading.—Grader No. 1 was transferred from Lake Providence October 20, ning the grading of the upper slope, range 134, on October 24. This work was ed and the grader moved to the head of the revetment to grade down the ridge eslope the upper bank preparatory to paving. The grader was in service until mber 11. Length of main bank graded, 450 linear feet, an average of 45 linear er day while engaged at this work.

e dressing and filling washouts.—This was done with scrapers and shovels. The paid for teams was $4 per day.

ing.—The work of stripping the revetment of stone where repairs were to be , and placing additional stone on the slope where necessary, was begun on mber 5. The entire paving was finished December 12; number of squares, 820. ne old stone was used in the work; the additional stone furnished per square .7 cubic yards.

ASHBROOK NECK REVETMENT (446 L.).

e damage to this work from last high water consisted of four small sloughs, at s 22 to 26, ranges 95 to 97, ranges 99 to 106, and ranges 121 to 124.

e experience of the past three seasons in making repairs at several isolated s along this revetment, and the fact that such work is expensive and unsatis- y, justify the conclusion that it would be much better in the long run, and be er, to make a thorough repair of the entire work by reenforcing it by the con- ion of a continuous fascine mat 250 feet wide. Under this plan the upper bank would require but little work. The cost of such a mat should not be more $12 per linear foot. The estimated cost for the entire work is $120,000. This l make the improvement permanent. The original work was begun in 1890, s of the old style of woven mat.

e original project provided for the repairs of one break in the revetment 300 ong. Before the season was over sloughs occurred at three other points, which ame necessary to repair.

e mat party arrived from Greenville November 25, and began work the follow- ay.

tress construction.—The dimensions of mats constructed were as follows:

	Squares.
nel mat No. 1, 575 by 250 feet	1,438
nel mat No. 2, 510 by 250 feet	1,275
et mat No. 1	134
et mat No. 2	293
et mat No. 3	758
et mat No. 4	243
et mat No. 5	316
Total	4,457

cket mat No. 4 was constructed to replace mat No. 2, which slid out into the This was caused by the weight of earth washed down on it from the bank e while being graded by the hydraulic grader.

e slope under water at this point was unusually steep.

ading.—Hydraulic grader No. 1 began work on December 1 and finished on the rading 1,248 linear feet of bank, an average rate of 83 linear feet for each work- ay.

Slope dressing.—This work was done with shovels, bank clearing being included under this head.

Paving.—Work was begun December 1 and was completed January 26. Amount paved, 1,081 squares; an average of 3.27 cubic yards of stone used per square. Exclusive of old stone used, 300 cubic yards of stone was loaded from the reserve on the bank and 327 cubic yards of stone from injured portions of the slope. The average cost was 33.8 cents per cubic yard.

GENERAL REMARKS ON REVETMENT WORK.

Towing.—The U. S. steamer *Emma Etheridge* was in commission from August 14 to January 28, employed principally in towing brush and poles and in the necessary work incident to mat building. The steamer *Arthur Hider* was in service from July 25 to August 21, and from September 22 to January 22, towing stone from Greenville to Lake Providence and Delta Point, and from Arkansas City to Greenville and Lake Providence, moving the outfits of the brush contractor and in inspection service.

Brush and poles.—Brush and poles were furnished for the different works under contract with Hunter & Frey. The price for brush was 90 cents per cord for Ashbrook Neck and Greenville and 94 cents per cord for Lake Providence and Delta Point; for poles, $1.75 per cord. The delivery was made promptly as required. There were delivered under this contract 24,061.7 cords of brush and 1,057.4 cords of poles.

Stone.—Contracts were made with Fred Hanger for the delivery of 15,000 cubic yards of stone on barges at Arkansas City, at $1.49 per cubic yard; with A. J. Terrell for 12,000 cubic yards on barges at Greenville, at $1.75 per cubic yard and 25 cents per cubic yard for loading the reserve; and with the Rankin Stone Company for 11,000 cubic yards loaded on barges below Vicksburg or on top of the bank at Delta Point, Louisiana, at $1.60 per cubic yard.

The first stone received on barges from the contractors was at Arkansas City September 2 and at Greenville September 11. On account of the delay in delivery it became necessary to supply the work at Lake Providence from the reserve at Greenville, and also about 1,000 cubic yards at Delta Point, due to the failure of the contractors to load stone in time to sink the first mat.

The failure of the contractors at Arkansas City and Greenville to supply stone in the earlier part of the season was due to the inadequate number of cars furnished by the railroad companies. At Vicksburg delay was experienced by reason of the poor facilities the contractors had for loading.

As soon as sufficient stone had been furnished to finish the season's work the contracts were canceled.

The following amounts of stone were received under these contracts:

	Cubic yards
Fred Hanger, Arkansas City	8,341.[illegible]
A. J. Terrell, Greenville	9,252.[illegible]
Rankin Stone Co., Vicksburg	4,006
Rankin Stone Co., Delta Point	4,658.[illegible]
Rankin Stone Co., Delta Point (reserve)	1,037.45
Amount loaded from reserve at Greenville	8,447.17
Amount loaded from reserve at Ashbrook Neck	300
Total	36,042.87
Less reserve at Delta Point	1,037.45
Total stone expended	35,005.42

All the reserve stone available at Greenville has been used. There is still on the bank at Ashbrook Neck about 900 cubic yards and at Delta Point 1,000 cubic yards. This is the extent of the reserve stone in the district.

If it had not been for the reserve stone at Greenville to draw from in the beginning of the season, the progress of the work would have been seriously crippled. Judging from the experience of past years, the only way to insure a prompt supply is to have a reserve on hand to draw from should the contractor be dilatory or fail. To accomplish this, the advisability of opening up the quarry in Little Red River as soon as the necessary funds are available is suggested. This quarry can be worked all the year round if desired, and good water for towing can usually be depended on for four months in the year—from January to June. During this period the towing plant is generally idle. The stone can be quarried in advance, so as to avoid delays in towing, and in this way delivered at less cost than it can be procured by contract, and, what is of the greatest importance, a full supply for the season's work can be insured in advance.

this connection a report of the survey, giving the extent and present condition
e quarry on Little Red River, with an estimate of the cost of quarrying, loading,
owing stone, recently made by Mr. George C. Thomas, superintendent of con-
ion, who had direct supervision of the work of mattress building the past sea-
s given below:

SEARCY, ARK., *April 26, 1900.*

: I have the honor to submit the following report on the location and descrip-
f the Government quarry property in White County, Ark., with an approxi-
estimate of operating expenses and plant required for an annual output of 50,000
yards of stone:

ation.—The property comprises all of that portion of the SE. ¼ of sec. 26, T. 8,
V., lying west of Little Red River in White County, Ark., about 30 miles above
outh of Little Red River and 380 miles from Greenville, Miss., the present loca-
f Third District plant.

cription.—The property contains 36½ acres and has a river frontage of 2,880 feet,
et of which was opened and operated by contractors during the years 1894,
1896, and 1898 in furnishing stone under contract to the United States for the
vement of the Mississippi River.

ır hundred feet additional can be added to the present quarry at a nominal cost
pping, giving a continuous quarry of the following dimensions: Length of front,
feet; average height of face (floor of quarry to top of cliff), 80 feet; present
ge width of floor (river bank to foot of cliff), 100 feet.

imating for a distance back of 200 feet, this quarry would contain about 1,000,000
yards of riprap.

the remainder of the property only a few isolated points can be worked with-
xcessive cost for yard room and stripping.

e quarry is composed principally of a fine gray sandstone weighing about 160
ls to the cubic foot; well stratified, varying in thickness from 6 to 18 inches,
easily quarried into smooth, rectangular blocks of any desired size, making it
arly well adapted to bank protection, being considered in point of handling
ability of work about 20 per cent cheaper than any other stone in use.

m section A to D (see plat) there is a ledge of nonstratified, coarse-grained
v sandstone, which, while not strictly a first-class stone, owing to lack of weight
endency to spall, is suitable for paving where not exposed to the direct action
rents.

face stripping is very light over the entire quarry, ranging from 1 to 3 feet of
rock and earth.

arrying.—The method that has proven best adapted to this stone is to bench it
s from 16 to 20 feet; holes from 6 to 10 feet apart, varying with thickness of
; distance back not to exceed depth of hole; blasting to be done with Judson
er and a low grade (30 per cent nitroglycerine) of dynamite.

arrying should begin from twenty to thirty days in advance of towing in order
ure a sufficient quantity of stone in the yard to insure against delays to the boats.

ing.—The quarry is reached from Greenville by the Mississippi, White, and
Red rivers. The usual period of navigation for the latter stream is from Feb-
1 to June 1, during which time there are no serious obstructions excepting
land Shoals, which could be materially improved by closing the western chute
emoving loose bowlders from the shoals.

o boats with the capacity of the steamer *Arthur Hider*, costing $100 per day, can
r 50,000 cubic yards of stone at Greenville, Miss., during the above period of
ation, each boat to operate the entire distance, with coaling stations at Green-
nd the quarry.

rating expenses.—Following is an estimate of operating expenses, based on an
t of 12,500 cubic yards per month of twenty days; loading to be done over a
ing barge with carts:

Force.

erintendent, 1 month, at $150	$150
k, 1 month, at $75	75
ter laborers, 1 month, at $75	300
hinist, 1 month, at $100	100
nan, 1 month, at $45	45
ksmith, 1 month, at $75	75
ker, 1 month, at $45	45
chman, 1 month, at $45	45
m driller, 20 days, at $1.25	25
nd drillers, 20 days, at $1.25	300
ne breakers, 20 days, at $1.25	375

30 laborers, 20 days, at $1	$600
12 carts (drivers included), 20 days, at $3	720
Total labor per month	2,855
Subsistence, at 50 cents per day	1,035
Powder, cost, at 6 cents per cubic yard	750
Fuel, oils, etc., per month	360
Total per month	5,000

$5,000÷12,500=40 cents per cubic yard on barge.

Plant.

Office and storeroom, 30 by 60 feet	$300
Cooking and eating quarters, 30 by 75 feet	400
Sleeping quarters, 30 by 100 feet	500
Dumping barge, labor and material for platform	200
1 steam boiler, portable, 30 H. P	450
2 steam drills, New Ingersoll, size F	800

Tools.

4 sets drills and bits	300
1 dozen hand drills, 1¼ inches by 2 feet	30
1 dozen hand drills, 1¼ inches by 4 feet	50
1 dozen hand drills, 1¼ inches by 6 feet	75
2 dozen quarry picks	30
1 dozen railroad shovels	20
1 dozen pinch bars (steel shank)	36
2 dozen spalling hammers (with handles)	100
2 dozen stone hammers (wedge face)	75
2 dozen stone gads	20
1 Magneto blasting machine	25
100 feet steam hose (1 inch, 6 ply, wire wound)	100
Total cost plant and tools	3,511

In compiling the foregoing estimate of plant no account has been taken of buildings already on the property. At a moderate outlay for labor in moving and remodeling the present buildings the estimate for buildings can be reduced one-half.

Following is a summary of cost of labor:

On barge at quarry	$0.4
Towing, quarry to Greenville	.4
Unloading on bank at Greenville	.2
Reloading for use	.2
Total cost per cubic yard	1.33

Property plat and quarry sections herewith.

Very respectfully,

GEO. C. THOMAS,
Superintendent Construction.

Detailed statements of the cost of the various items of revetment work are submitted herewith.

Cost per unit of work done, Lake Providence, season 1899–1900.

	Unit.	Pay roll.	Subsistence.	Material.	Total.	Cost per unit.
Channel mat	squares..	5,700	$7,246.13	$2,090.56	$19,165.10	$28,501.79	$5.00
Pocket mat	do....	767.5	1,098.82	316.76	2,469.10	3,884.68	5.06
Dressing slope	linear feet..	1,900	1,599.96	461.69	.....	2,061.65	1.08
Paving bank	squares..	2,510	2,827.60	815.78	14,120.87	17,764.25	7.07
Hydraulic grading	linear feet..	1,900	1,088.92	194.29	561.35	1,844.56	.97
Towing	.....	.....	3,319.92	785.30	1,640.98	5,746.20	.....
Superintendence	.....	.....	1,223.94	88.43	.....	1,312.37	.....
Property purchased	.....	.....	.....	.....	.....	1,508.38	.....
Sundries	.....	.....	.....	.....	.....	191.29	.....
Memphis office	.....	.....	.....	.....	.....	1,485.67	.....
Total	.....	.....	18,405.29	4,752.81	37,957.40	64,300.84	.....

cost of work done	$64,300.84
cost of Memphis office	1,485.67
Net amount expended	62,815.17

62,815.17 ÷ 1,900 (linear feet of work) = $33.06 per linear foot, net average.
64,300.84 ÷ 1,900 (linear feet of work) = $33.79 per linear foot, gross average.

Percentage of cost of different kinds of work, Lake Providence.

	Pay roll.	Subsistence.	Material.	Total.	Per cent.
el mat	$7,246.18	$2,090.56	$19,165.10	$28,501.79	44.32
mat	1,098.82	316.76	2,469.10	3,884.68	6.04
g slope	1,599.96	461.69	.....	2,061.65	3.21
ulic grading	1,088.92	194.29	561.35	1,844.56	2.87
bank	2,827.60	815.78	14,120.87	17,764.25	27.63
g	3,319.92	785.30	1,640.98	5,746.20	8.94
ntendence	1,223.94	88.43	.....	1,312.37	2.04
ty purchased	.....	.....	.....	1,508.38	2.35
es	.....	.....	.....	191.29	.29
his office	.....	.....	.....	1,485.67	2.31
Total	18,405.29	4,752.81	37,967.40	64,300.84	100

Material expended per unit of work, Lake Providence.

[Channel mat, 5,700 squares.]

Material.		Quantity.	Per square.
	cords	8,721	1.53
	do	342	.06
	cubic yards	4,560	.80
trand:			
nch	pounds	23,587	4.14
inch	do	16,513	2.90
nch	do	2,725	.50
nch	do	37,221	6.53
No. 12, galvanized	do	10,887	1.91
silicon bronze	do	5,643	.99
magnolia	number	1,650	.29
s	pounds	969	.17
	do	450	.08

[Pocket mat, 767.5 squares.]

	cords	1,188.9	1.55
	do	78.3	.10
	cubic yards	614	.80
trand:			
inch	pounds	2,302	3
nch	do	4,997	6.53
No. 12, galvanized	do	1,493	1.91
silicon bronze	do	743	.97
s	do	131	.17

[Bank paving, 2,510 squares.]

	cubic yards	8,474.95	$3.37

Material expended per linear foot completed work, Lake Pro

[Amount of work completed, 1,900 linear feet.]

Material.	
Brush	cords..
Poles	do....
Stone	cubic yards..
Wire strand:	
⅜ inch	pounds..
⅝ inch	do....
¾ inch	do....
⅞ inch	do....
Wire No. 12, galvanized	do....
Wire, silicon bronze	do....
Slips, magnolia	number..
Staples	pounds..
Spikes	do....

Percentage of cost of different items of work, Lake Provi

Pay roll	
Subsistence	
Material	
Sundries	
Memphis office	
Property purchased	
Total	

Cost per unit of work done, Delta Point, La., season 1899-

	Unit.	Pay roll.	Subsistence.	Material
Channel mat	squares..	2,148	$2,252.01	$597.15	$8,451.4
Pocket mat	do....	1,182	1,154.37	306.07	4,482.4
Grading bank	linear feet..	1,500	1,829.52	485.09	.....
Paving bank	squares..	1,830	1,951.43	517.40	12,243.1
Towing	.....	.....	1,984.36	412.16	1,270.3
Supervision	.....	.....	712.05	51.13	.....
Property purchased	.....	.....	.....	.....	.....
Sundries	.....	.....	.....	.....	87.5
Memphis office	.....	.....	.....	.....	.....
Total	.....	.....	9,883.74	2,369.00	26,535.0

Total cost of work done	
Less overhaul on brush	
Less charge for loading stone	
Less cost of Memphis office	
Net amount expended	

$38,871.78 ÷ 1,500 (linear feet of work) = $25.91 per linear foot, net average.
$40,781.40 ÷ 1,500 (linear feet of work) = $27.19 per linear foot, gross average.

Percentage of cost of different kinds of work, Delta Point

	Pay roll.	Subsistence.	Material.
Channel mat	$2,252.01	$597.15	$8,451.49
Pocket mat	1,154.37	306.07	4,482.48
Grading bank	1,829.52	485.09	.....
Paving bank	1,951.43	517.40	12,243.19
Towing	1,984.36	412.16	1,270.31
Supervision	712.05	51.13	.....
Property purchased	.....	.....	.....
Sundries	.....	.....	87.55
Memphis office	.....	.....	.....
Total	9,883.74	2,369.00	26,535.02

Material expended per unit of work done, Delta Point, La.

[Channel mat, 2,148 squares.]

Material.	Quantity.	Per square.
.....cords..	3,351	1.56
.....do....	142	.07
.....cubic yards..	2,148	1
rand:		
ch.....pounds..	12,723	5.92
nch.....do....	3,370	1.57
ch.....do....	14,477	6.74
alvanized, No. 12.....do....	2,921	1.36
licon bronze.....do....	1,589	.74
agnolia.....number..	650	.30
.....pounds..	192	.09
.....do....	200	.09

[Pocket mat, 1,182 squares.]

Material.	Quantity.	Per square.
.....cords..	1,855.5	1.57
.....do....	79.2	.07
.....cubic yards..	1,182	1
rand:		
nch.....pounds..	5,125	4.34
ch.....do....	7,963	6.74
alvanized, No. 12.....do....	1,603	1.36
licon bronze.....do....	871	.74
.....do....	118	.09

[Bank paving, 1,830 squares.]

.....cubic yards..	7,370.58	4.03

Material expended per linear foot completed work, Delta Point, La.

[Amount of work completed, 1,500 linear feet.]

Material.	Quantity.	Per linear foot.
.....cords..	5,206.5	3.47
.....do....	221.2	.15
.....cubic yards..	10,700.58	7.13
rand:		
nch.....pounds..	12,723	8.48
nch.....do....	8,495	5.67
ch.....do....	22,440	14.96
alvanized, No. 12.....do....	4,524	3.02
licon bronze.....do....	2,460	1.64
agnolia.....number..	650	.43
.....pounds..	300	.20
.....do....	200	.14

Percentage of cost of different items of work, Delta Point, La.

	Amount.	Per cent.
ll.....	$9,883.74	24.29
ence.....	2,369.00	5.82
al.....	26,535.02	64.99
ty purchased.....	142.07	.35
his office.....	1,851.57	4.55
otal.....	40,781.40	100

Cost per unit of work done, Greenville Harbor, season 1899–1900.

	Unit.	Pay roll.	Subsistence.	Material.	Total.	Cost per unit.
Pocket mat	squares..	883	$805.75	$80.99	$2,738.26	$3,625.00	$4.10
Paving bank	do....	820	943.68	94.86	3,834.25	4,872.79	5.94
Hydraulic grading	linear feet..	450	445.70	.....	100.00	545.70	1.21
Dressing slope	do....	450	349.26	35.10	100.00	484.36	1.07
Brush revetment	squares..	479	309.53	31.11	1,802.91	2,143.55	4.47
Minor repairs	.....	.....	1,415.52	142.39	944.50	2,502.41	.....
Towing	.....	.....	265.51	54.32	229.90	549.73	.....
Superintendence	.....	.....	333.33	5.18	.....	338.51	.....
Sundries	.....	.....	.....	.....	3.80	3.80	.....
Barges, stone, etc	.....	.....	.....	.....	.....	26,330.67	.....
Total	.....	.....	4,868.28	443.95	9,753.62	41,396.52	.....

Total cost of work done	$41,396.52
Less cost of barges, stone, etc	26,330.67
Net amount expended	15,065.85

Percentage of cost of different kinds of work, Greenville Harbor.

	Pay roll.	Subsistence.	Material.	Total.	Per cent.
Pocket mat	$805.75	$80.99	$2,738.26	$3,625.00	8.75
Paving bank	943.68	94.86	3,834.25	4,872.79	11.75
Hydraulic grading	445.70	.....	100.00	545.70	1.32
Slope dressed	349.26	35.10	100.00	484.36	1.17
Brush revetment	309.53	31.11	1,802.91	2,143.55	5.18
Minor repairs	1,415.52	142.39	944.50	2,502.41	6.04
Towing	265.51	54.32	229.90	549.73	1.33
Superintendence	333.33	5.18	.....	338.51	.82
Sundries	.....	.....	3.80	3.80	(a)
Barges, stone, etc	.....	.....	.....	26,330.67	63.64
Total	4,868.28	443.95	9,753.62	41,396.52	100

a Less than one-half of one-hundredth; neglected.

Material expended per unit completed work, Greenville Harbor.

[Pocket mat, 883 squares.]

Material.	Quantity.	Per square.
Brush	cords..	1,324	1.5
Poles	do....	62	.07
Stone	cubic yards..	750.28	.85
Wire strand:			
$\frac{5}{8}$ inch	pounds..	2,500	2.83
$\frac{1}{4}$ inch	do....	4,200	4.76
Wire, galvanized, No. 12	do....	500	.57
Wire, silicon bronze	do....	275	.31
Staples	do....	20	.02

[Paving bank, 820 squares.]

Stone	cubic yards..	2,191	2.7

[Brush revetment, 479 squares.]

Brush	cords..	475.7	.99
Poles	do....	83.7	.18
Stone	cubic yards..	718.4	1.5
Wire, galvanized, No. 12	pounds..	400	.84

Percentage of cost of different items of work, Greenville Harbor.

	Amount.	Per cent.
y roll	$4,868.28	11.76
bsistence	443.95	1.07
terial	9,454.12	22.84
am hire	299.50	.72
rges, stone, etc	26,330.67	63.61
Total	41,396.52	100

Cost per unit of work done, Ashbrook Neck, season 1899–1900.

	Unit.	Pay roll.	Subsistence.	Material.	Total.	Cost per unit.
annel mat	squares..	2,713	$3,259.58	$1,029.82	$9,309.30	$13,598.70	$5.01
cket mat	do....	1,744	2,693.35	850.94	5,611.59	9,155.88	5.25
ssing slope	linear feet..	1,248	225.28	71.17	.....	296.45	.23
ving slope	squares..	1,081	1,381.85	436.58	5,210.65	7,029.08	6.50
ading stone	cubic yards..	627	161.20	50.83	.....	212.03	.34
draulic grading	linear feet..	1,248	584.18	109.45	90.00	783.63	.63
wing	.....	.....	1,777.00	383.12	748.95	2,909.07	.....
perintendence	.....	.....	1,275.00	51.17	.....	1,326.17	.....
operty purchased	.....	.....	.....	.....	.....	65.90	.....
ndries	.....	.....	.....	.....	107.30	107.30	.....
mphis office	.....	.....	.....	.....	.....	779.33	.....
Total	.....	.....	11,357.44	2,983.08	21,077.79	36,263.54	.....

tal cost of work done		$36,263.54
ss cost of Memphis office	$779.33	
s loss barge No. 551	471.22	
ss amount charged Fred Hanger, use pile driver and labor	166.32	
		1,416.87
Net amount expended		34,846.67

Percentage of cost of different kinds of work, Ashbrook Neck.

	Pay roll.	Subsistence.	Material.	Total.	Per cent.
annel mat	$3,259.58	$1,029.82	$9,309.30	$13,598.70	37.49
cket mat	2,693.35	850.94	5,611.59	9,155.88	25.27
ssing slope	225.28	71.17	.....	296.45	.82
ving bank	1,381.85	436.58	5,210.65	7,029.08	19.38
ading stone	161.20	50.83	.....	212.03	.58
draulic grading	584.18	109.45	90.00	783.63	2.16
wing	1,777.00	383.12	748.95	2,909.07	8.02
perintendence	1,275.00	51.17	.....	1,326.17	3.66
operty purchased	.....	.....	.....	65.90	.18
ndries	.....	.....	107.30	107.30	.29
mphis office	.....	.....	.....	779.33	2.15
Total	11,357.44	2,983.08	21,077.79	36,263.54	100

Material expended per unit of work done, Ashbrook Neck.

[Channel mat, 2,713 squares.]

Material.	Quantity.	Per square.
sh cords..	4,341	1.60
es do....	163	.06
ne cubic yards..	1,899	.70
re strand:		
¾-inch pounds..	19,017	7.01
½-inch do....	3,828	1.41
⅜-inch do....	6,801	2.51
¼-inch do....	16,875	6.22
re:		
No. 12, galvanized do....	5,290	1.95
Silicon bronze do....	841	.31
ps, magnolia number..	200	.07
ples pounds..	542	.20
kes do....	550	.20

Material expended per unit of work done, Ashbrook Neck—Continued

[Pocket mat, 1,744 squares.]

Material.	Quantity
Brush ..... cords..	2,804.
Poles ..... do....	112.
Stone ..... cubic yards..	1,221
Wire strand:	
⅝-inch ..... pounds..	5,385
½-inch ..... do....	10,861
Wire:	
No. 12, galvanized ..... do....	3,410
Silicon bronze ..... do....	529
Staples ..... do....	388

[Bank paving, 1,081 squares.]

Stone ..... cubic yards..	3,535.2

Percentage of cost of different items, Ashbrook Neck.

	Amount
Pay roll	$11,357.4
Subsistence	2,983.0
Material	21,077.7
Property purchased	65.9
Memphis office	779.3
Total	36,263.5

PLANT.

New plant.—During the year two new mat boats and 12 material barges built under contract.

Dimensions of mat boats, 160 by 35 by 6 feet; dimensions of material b by 30 by 6 feet. The mat barges were constructed by Ed. J. Howard, at ville, Ind.; contract price, $4,710 each, and the material barges by John Son, at Levanna, Ohio; contract price, each, $2,846.

The two mat barges and seven of the material barges were delivered at and towed to Greenville by the steamer *Arthur Hider*, arriving Decembe remaining five barges have since been finished (the last one on April 28) be delivered at Greenville by the contractor.

Cost of repairs to plant, Third district, improving Mississippi River, May 1, 18 1, 1900.

Number or name.	Cost.	Remarks.
Steamer—		
Emma Etheridge	$523.87	Repairs to guards and head, 2 new chocks and 5 plank sheer and nosing, new half sheet in new plummer block, and ordinary repairs du
Arthur Hider	400.95	Additional braces to sampson post, rudder bum ened, repairs to steering rigging, engines lin nary repairs during season.
Vedette	277.54	Repairs to guards, deck, and main braces; 3 ne
Meter	134.90	Repairs to boiler-deck guards and wheel; 3 r calking above light water.
Tug Parker	864.67	Docked; bed timbers under engine; 18 new fram 4 strakes in hold; nosing around stem; botto calked; new wheel and sternbearing brass; hauled, and ordinary repairs during year.
Grader—		
No. 1	120.10	Repairs to electric-light outfit; new stack for n ordinary repairs during year.
No. 3	228.89	Repairs to broken steam and water cylinders; r all flanges and heads; repairs to stage and do

t of repairs to plant, Third district, improving Mississippi River, May 1, 1899, to May 1, 1900—Continued.

Number or name.	Cost.	Remarks.
ttress boat—		
No. 26	$219.02	7 new skids, 15 new outriggers, 6 plank-sheer, 1 stanchion; repairs to bits and deck; lower seams calked.
No. 188	642.52	Dismantled and made into a barge; 22 beams, 10 stem pieces, 5 timber heads, sheathing sides and deck, sides and rakes repaired; calked.
No. 28	456.24	Rigging for launching fascines made; yokes, brakes, reel standards, and shaftings complete.
No. 27	287.66	3 new skids; 20 outriggers; 6 plank-sheer on end; 1 stanchion, repairs to bitts and deck; lower seams calked.
No. 29	454.28	Rigging for launching fascines made; reel standards and shafting complete.
del barge—		
Apache	6.23	Battening holes in rake.
Cheyenne	58.78	Battening holes; 5 lower seams calked.
Maricopa	82.50	Sheathing hole in deck; battens in hold; 5 lower seams calked.
Nez Perce	50.66	Calking 5 lower seams.
Shoshone	40.93	1 new plank in side; calking lower seams.
ge—		
No. 79	63.53	Repairs to deck; 1 new kevel; calked above light water.
No. 80	57.40	Repairs to deck; calked above light water.
No. 82	178.26	2 head blocks, 2 kevels, 2 timber heads, 2 plank in rakes, sheathing gunwale inside where broken; calked above light water.
No. 83	135.75	Docked; spiking down battens; lower seams calked.
No. 84	4.52	Battens along the chime seam.
No. 108	12.32	4 timber heads; calking lower seams.
No. 137	24.42	Calking lower seams.
are barge—		
No. 551	226.99	Docked; rakes, sides, and deck repaired.
No. 552	357.78	Docked; rakes repaired; calked.
No. 553	217.14	Docked; rakes repaired; deck and hoods repaired; calked.
No. 554	298.99	Docked; rakes and deck repaired; calked.
No. 555	247.15	Docked; repairs to rakes; lower seams and rakes calked.
No. 556	219.92	Same.
No. 557	261.49	Docked; rakes, deck, and hoods repaired; lower seams calked.
No. 558	253.09	Docked; rakes, deck, and hoods repaired; 2 timberheads, 1 kevel; calked.
No. 559	276.88	Docked; rakes, deck, and hoods repaired; 2 new kevels; calked.
No. 560	221.96	Docked; 1 piece of plank-sheer; 1 piece of gunwale; rakes, deck, and hoods repaired.
No. 561	272.69	Docked; rakes, deck, and hoods repaired; sides and rakes calked.
No. 562	269.39	Docked; 4 pieces of plank-sheer, 2 new gunwales; rakes, deck, and hoods repaired; calked.
No. 563	238.63	Docked; 1 timberhead, rakes, deck, and hoods repaired.
No. 564	284.68	Docked; rakes, deck, and hoods repaired; calked.
No. 565	224.39	Docked; rakes and deck repaired; calked.
No. 210	488.94	Docked; sides and rakes repaired; calked.
No. 224	578.29	Docked; sides and rakes repaired; 2 timberheads; new deck; calked all over.
No. 225	50.26	Six new timberheads; repairs to sides; sheathing holes in deck; calked 5 lower seams.
No. 226	27.64	Two new timberheads; braces in hold; sheathing holes in deck; calking 5 lower seams.
rter boat—		
No. 16	6.95	Calking lower seams.
No. 17	840.62	Docked; new bottom plank and rake, new bottom gunwale, 30 outriggers, 25 new braces, 6 streamers, 14 stem pieces, 8 halfway pieces; cabin repaired; calked and painted.
No. 19	108.65	New timberheads, new head block, new bottom in ice box; guards repaired; calked above light water.
No. 31	157.43	Painted; minor repairs to woodwork.
No. 38	46.59	Office sealed and outside painted.
No. 86	313.29	Docked; 24 new rake plank; 14 stems, 5 halfway pieces in the sides, 6 pieces of gunwales, 1 timberhead, new nosing on corners; roof, doors, and bunks repaired; calked.
No. 87	5.06	Repairs to cooking ranges.
No. 88	416.82	Docked; 14 new stem pieces, 8 halfway pieces; 26 plank on rakes, 4 plank on bottom, plank-sheer on guard, nosing on corners, 50 outriggers, railing guards and ends; sides and rakes, calked; painted.
No. 136	61.96	Cooking range repaired; calked low seams.
No. 154	625.16	Docked; new head blocks, deck and deck frames on end, outriggers, plank-sheer, and nosing on corners; 2 pieces of plank-sheer on sides, stern, and rakes, halfway up; 1 piece of gunwale, 5 halfway pieces, new hatch covers, roof, bunks, and tables repaired; calked.

Cost of repairs to plant, Third district, improving Mississippi River, May 1, 1899, to May 1, 1900—Continued.

Number or name.	Cost.	Remarks.
Quarter boat—		
No. 155	$137.29	Ceiled over dining room, and painted; lower seams calked; general repairs to kitchen outfit during year.
No. 156	152.82	Guards and deck repaired; new railing on guards, 1 new timberhead, cabin and bunks repaired, minor repairs during year; outside and inside painted.
No. 157	39.34	Two new timberheads; minor repairs during year.
No. 158	629.30	Docked; 14 pieces of gunwales in sides; 16 stems, 24 rake plank, 10 halfway pieces, 4 plank in bottom, 3 timberheads, 6 beams, 50 outriggers, deck and guards on end repaired; calked all over.
No. 159	377.73	Docked; 18 halfway pieces in sides; 14 stems, 1 timberhead, deck and guards repaired; calked.
Store boat No. 138	22.45	Calking lower seams.
Memphis office	15.24	Tool box.
Machine shop No. 222	327.48	New deck on ends; new apron on head, head blocks, 6 beams, 5 outriggers, 1 timberhead, 1 kevel, new nosing on end, repairs to plank-sheer, calking deck and low seams, 4 corner irons; general repairs to machinery during season.
Carpenter shop No. 78	207.42	New deck on one end; 3 timberheads; repairs to hatch covering; calking low seams, general repairs to machinery during year.
Dry dock	674.68	Practically new gate; new supporting brackets underneath; repairs to fenders at inlet pipes, repairs to cushion on gate, and shoring up boilers; 4 straps and 36 bolts.
Pile driver No. 49	96.08	Braces, leads, and ladder deck repaired; 2 new chocks, 1 new kevel, lower seams calked.
Calking flat	48.81	1 new one made.
Dump scow No. 2	8.50	Battening seams.
Ashbrook Neck	11.09	Repairing tools and machinery.
Levees	73.51	Office furniture: 1 blue-print frame and 1 bookcase made.
Greenville Harbor	164.47	Repairing tools, kitchen outfit repaired, clamps and clevises made.
Lake Providence Reach	451.23	616 cable clamps, 120 couplings, and 36 bolts made; 12 picks, 8 mattocks, 8 skiffs, 1 kitchen pump, 1 ratchet, and kitchen utensils repaired; 8 shackles and 16 maul handles made.
Coal boxes	68.26	46 repaired and 6 made.
Skiffs	8.43	4 repaired.
Surveys	1.62	100 stakes made.
Property	73.20	Repairs to kitchen outfit during year.
Pumps	310.26	154 pumps repaired.
Fourth district plant	8.66	1 standard for grader No. 3.
Wages, cooks and waiters	800.45	
Superintendence	1,850.00	
Total	19,383.09	

Approximate value of plant belonging to the United States and used in the Third district, improving Mississippi River, May 1, 1899, to May 1, 1900.

Class of property.	Number.	Approximate value.	Class of property.	Number.	Approximate value.
Steamer Arthur Hider	1	$35,577	Square barges (new)	9	$25,614
Steamer Emma Etheridge	1	6,300	Square barges	22	6,930
Steamer Meter	1	3,160	Floating dry dock	1	9,900
Steamer Vedette	1	4,050	Floating ponton docks	2	405
Tug Parker	1	3,150	Pile drivers and outfits	2	1,260
Mat boats Nos. 26 and 27	2	6,300	Tools and appliances	.....	1,800
Mat boats (new) Nos. 28 and 29	2	9,410	Skiffs	21	210
Mat boats (old)	2	650	Dredge Menge	1	7,650
Headquarter boat No. 31	1	3,150	Dump scow No. 2	1	.....
Quarter boats	14	12,410	Calking flats	4	90
Store boat	1	900	Office furniture and safes	.....	250
Hydraulic graders	2	9,900	Surveying instruments	.....	1,800
Hydraulic graders, small	1	800	Machine shop and outfit	1	3,800
Model barges	5	500	Carpenter shop and outfit	1	2,700
Floating stern dock	1	90			
Square barges	13	22,700	Total	114	181,456

The cost for the twelve months for caring for the above property, plant, and outfit thereon was $20,236.59.

The average number of employees engaged in the service was 39.

The average daily cost for subsistence for employees engaged in care and repairs to nt was 34.2 cents.

Very respectfully,

ARTHUR HIDER, *Assistant Engineer.*

Capt. CHAS. L. POTTER,
Corps of Engineers, U. S. A.

REPORT OF MR. H. ST. L. COPPÉE, ASSISTANT ENGINEER.

GREENVILLE, MISS., *May 10, 1900.*

APTAIN: I have the honor to submit the following report of operations in the er Yazoo Levee district during the year ending May 1, 1900:

xtent of district and yardage.—The line of levee in the district has had 1 mile added e last year, making the total length from the Coahoma County line to the lower of Eagle Lake in Warren County 188¼ miles.

my last annual report the yardage in this entire line was estimated as 26,883,717. included the portions of the Hays and Albemarle loops that were completed, ell as the outside lines then intact.

shown in the accompanying statements of work done, the United States added ng the year 1,850,200 cubic yards, and the levee board 1,068,576 cubic yards, ing a total of 2,918,776 cubic yards from May 1, 1899, to May 1, 1900.

he average price for all material moved by the United States was about 16⅔ cents, by the levee board, 16 cents. The United States Government work includes the s Loop day work, which cost 18.34 cents per yard, and some very expensive ing.

he yardage deducted for levees thrown out by new levees during the year is as ws:

	Stations.	Miles below Cairo.	Cubic yards.
ton	1594+91 to 1663	400 L	323,882
ns	3120+80 to 3148+68	432 L	82,432
o	3163 to 3189	432 L	80,366
	4076 to 4215+55	555 L	260,174
narle	4750 to 4887+35	568 L	223,213
Total			970,067

he levee line at the present time contains 28,832,426 cubic yards.

RIVER STAGES AND CHANGE IN BANK.

May 10, 1899, the gauge read at Greenville 34.6. The water that reached a of 43 feet, April 17 to 20, had fallen, and continued to fall until November 3, n the reading was 1.2. Up to the present time no high water has obtained, and ng from present conditions we will probably not have a very high stage this year.

he changes that have occurred in the bank line, due to caving, etc., are as follows:

stralia to Dennis Landing.—From Stations 250 to 270 there has been no change, hence to about Station 450 the bank has been cut back, as shown in accompany-ketch,[1] as much as 1,000 feet since 1892. At the point of most excessive caving evee is still 1,500 feet distant. With a continuation of the same rate of change nain line will be reached at one point in about five years.

axhaw Front.—At Waxhaw the bank is caving. Since 1895 the average has been t 800 feet. At the nearest point the bank is 1,100 feet from the main levee.

verton.—At Riverton, Stations 1540 to 1645, the change has not been extensive. d caving only occurs there during high water. The bank nearest the old levee ins practically in the same position as when the new loop was located.

livar to Kentucky Landing.—In this reach, Stations 2590 to 2790, though the cav-ince 1894 averages some 600 feet, the change in the last year has been practically During the summer of 1899 the upper end of the revetment, which was pro-d by a deposit of sediment, was uncovered by a local low-water change in channel,

[1] Omitted.

but the revetment was not materially damaged. It is being covered again during the higher stages that have occurred this spring.

Jenkins to Mound Landing Front.—The levee in this reach, from Stations 3120 to 3330 and below to Huntington, a total distance of about 5 miles by river, has been threatened for some years. In 1897 the crevasse at Stops Landing necessitated the construction by the United States of a very extensive loop, Stations 3218+70 to 3272+29. In the reports of 1898 and 1899 will be found a description of this levee, the difficulty arising from its sinking, the remedy, etc. During the past season the levee board constructed the two Jenkins loops. If the caving in this reach does not become more extensive it may be necessary and advisable to construct one or two more short temporary levees in the next few years, but owing to the very poor foundation and low ground back of the present line, should the caving become active and general the levee will have to be located behind Lake Bolivar, leaving the present line at about Station 2550 and joining it again below the upper end of the Huntington Short Line, which is at Station 3330+70, and throwing out a large section of country (about 22 square miles) now protected. It is not probable that the necessity for the latter location will arise for two or three years. A slight change in the direction of flow and the abandonment by the main current of the river of the narrow chute in front of Eutaw Landing would solve the problem very effectively, preventing the expenditure of a large amount of money on the back line, and the accompanying land damage complications. Between Mound Landing and Huntington the river continues to approach the old line, and will probably destroy its continuity before the end of another high-water season.

Millers Bend.—The distance as measured out on the old levee, Station 3851+80, shows no appreciable caving in the last year.

Bachelors Bend Front.—In this bend, from the angle in the old levee opposite the angle at Station 3916+18 to the head of the Greenville revetment at Station 4120, the change since 1898 has averaged about 300 feet. At Station 4006, the nearest point of approach, the river is 575 feet from the levee, and the change in two years has been approximately 375 feet. If the same rate of caving continues at this point, which is not anticipated, another loop will have to be constructed in less than two years. This loop, if necessary in that time, will probably contain about 150,000 cubic yards and cost about $25,000. Temporary expedients can be resorted to at much less expense.

Longwood.—The bank along this front from Stations 1420 to 1530 is caving at an average rate of about 250 feet per year which, if continued, will necessitate the construction of a new loop in about five years.

Leota Loop, Stations 2000 to 2108.—The change in this reach, except at the lower end, has been slight. At the lower end about 200 feet of the bank has been swept away in the last year. The main levee is still 1,700 feet distant from the nearest point of caving.

Bend of Island 92.—The bank continues to cave in this reach from Stations 2400 to 2570. As well as can be determined with the water in the old chute, at the present time the nearest point of caving is a little less than 1,500 feet from the levee. No trouble is anticipated in this bend for some years to come.

Homochitto to Baleshed.—There has been little change here. The bank in the vicinity of the small Baleshed Loop, Station 3190, has been watched with great care during the year, owing to its close proximity to the levee at the principal point of attack of the current, but no material change has occurred. It is very probable that the next high water will continue to build the Homochitto Bar down until it reaches in front of this loop, thus solving the difficulty at this point. At medium stage, 26 feet on the Lake Providence gauge, 8 per cent of the river's discharge is through the Stack Island Chute, but I do not anticipate an enlargement of the chute in the near future or a radical change in river conditions (i. e., by cut-off through the chute) at any time. The tendency seems to be rather for the river to cut off the head of Stack Island, maintaining its present direction of flow.

Shipland.—Along the Shipland front there was little appreciable change last season and none is anticipated.

Fillers.—At the angle, Station 3980, it is difficult to foretell what will happen in the future. The material of which the bank is composed at this point is very hard, tenacious buckshot and clay, which is worn away by the action of the current very slowly. In the "Island No. 95 Reach" above and from Station 4000 to Shiloh Landing (Station 4210) below, the change has been slight the past year. Should the projecting point, Station 3980, be cut away, a loop could be constructed without banquet that would last for a few years, containing about 65,000 cubic yards, for about $9,000. Owing to the very considerable change in angle at Station 3980, and the fact that the

: of attack is directly at that angle, a small temporary loop that would throw the back decidedly could be constructed at less expense. It is not expected that r will be needed until after another high water.

Demarle to Warren County line.—This is a continuous caving bend from about on 4725 to 5100, by way of present river channel, nearly 6 miles. The material hich the bank is composed is, to a great extent, sand, and the caving, except at owest stages, is quite active, and has been so for over ten years, necessitating onstruction of numerous expensive levees in that time. At present rate of cav- he levee from Stations 4880 to 4950 will be threatened in less than five years. ated in my report last year, "It is not a great distance from the levee to Steeles u, which drains a large section of country directly back of the levee from Lakes and Washington (back of Leota) into the Yazoo near its old mouth. Should ver cut its way into this bayou, the point of intersection would probably be the nus of the levees in this district, unless an immense sum of money was expended in ng Steeles Bayou into Deer Creek or some other channel east of its present bed."

unswick front.—The bank on this front from opposite Station 5170 to Station +76 has caved slowly. Since 1894 it has been cut back at one point (Station over 500 feet, leaving a berme of about 600 feet between river and levee. In st year the change has been slight. Below Brunswick to the end of the district evee is away from the river and not exposed at any point to caving banks.

ough unforeseen causes may produce results that can not be taken into account imating the probable change in bank lines in the district from the present until May, judging from present conditions and those in the immediate past, no new will be absolutely necessary in that interval of time.

CONSTRUCTION.

e season has been a most favorable one for levee construction, and the rainfall, own in the accompanying table, has been far below the average. No high water iled to prevent the completion of existing contracts. All the work contem- d has been finished, nearly all on contract time. With the exception of one nette, containing 76,331 cubic yards, the work consisted in enlargement and ng. An accompanying table gives its extent and location by stations and river nces. Another table[1] gives the condition of the entire line in detail at the pres- me. The usual methods of construction by wheel scrapers have been prac- no other mechanical contrivances being adopted or experimented with as g the preceding season.

ntington short line.—When the last annual report was made the new Hunting- ne was completed all but the gap at Black Bayou. The injunction was still in and continued so until February 20, when by agreement of opposing counsel it issolved, and the work of closing the line proceeded to completion, being fin- March 31. The decision of the Supreme Court was in favor of the plaintiff, ning the constitutional jurisdiction of the land commissioners in valuing land ges *outside* of the right of way, and the justice of all such claims by riparian rs, also sustaining the injunction. On receipt of the decision of the Supreme Court evee board agreed to summon the commissioners and have the damages assessed, as above stated, the injunction was dissolved.

the amount of damages assessed by the commissioners was such a small per- ge of the amount sued for an appeal has been taken to the circuit court, but oes not in any way affect the levee, which is now intact, completed, and con- us.

ore dismissing the subject of this short line, I desire to repeat what was stated last report to the effect that, "While the damage to the interests of the local ent and property holder is recognized, the great benefit to be derived from per- nt lines like the Huntington short line is so far-reaching that this damage be very great to balance it.

ermanence, and economy of maintenance and future enlargement, are very g reasons for a radical departure in the location of levees in the future. Not ut regard to the interest of riparian owners, for whose benefit the levee is con- ed, but having in view the necessity, at all times, of damaging the few in order a permanent and reliable system of levees may be economically obtained and tained for the greater benefit of the many. As the flood plane rises with the ction of the levee system, new lines become more expensive, and temporary or tive locations will surely incur expense beyond the power of the State and the tion of the Government to contract."

[1] Omitted.

Estimates for continued construction.—The following estimates give the work to be done in order to build the levees in the district to standard section and a grade 3 feet above the high water of 1897:

Stations.	Miles below Cairo.	Kind of work.	Yardage.
0– 100	365 L....	Banquette	40,000
679– 700	375 L....	Banquette enlargement	10,000
712– 728	376 L....		
736– 749	377 L....		
780– 809	378 L....		
1146–1183	392 L....	.....do	5,000
1218–1286	394 L....	.....do	10,000
1286–1380	396 L....	Banquette	10,000
1511–1544	398 L....	Banquette enlargement	5,000
1650–1843	400 L....	Banquette	30,000
2116–2320	404 L....	Banquette enlargement	25,000
2320–2520	416 L....	.....do	48,000
2520–2720	417 L....	.....do	27,000
2233–2413	415 L....	Enlargement	100,000
2850–2992	420 L....	Banquette enlargement	20,000
2992–3121	432 L....	Banquette	60,000
3149–3163	433 L....	.....do	10,000
3272–3331	435 L....	Banquette enlargement	15,000
3331	436 L....	Dike old levee enlargement	8,000
3408	436 L....	Dike	15,000
3492	436 L....	.....do	20,000
3562	445 L....	Dike old levee enlargement	8,000
3562–3725	455 L....	Banquette enlargemen	20,000
3613–3852	459 L....	Enlargement	150,000
3725–3813	458 L....	Banquette	20,000
3811–3916	460 L....	Banquette enlargement	15,000
3081–4006	475 L....	Banquette	5,000
4006–4129	476 L....	Banquette enlargement	4,000
4129–4150	477 L....	Banquette	5,000
4209–4289	478 L....	.....do	5,000
200– 225	482 L....	.....do	5,000
225– 550	485 L....	.....do	8,000
550– 789	490 L....	.....do	27,000
976–1070	495 L....	.....do	35,000
1130–1346	496 L....	.....do	50,000
1346–1730	500 L....	Banquette enlargement	85,000
1730–1977	505 L....	Banquette	20,000
1977–2572	510 L....	.....do	120,000
2572–2730	530 L....	Banquette enlargement	35,000
2730–2913	532 L....	Banquette	35,000
2913–3054	535 L....	Banquette enlargement	50,000
3054–3144	537 L....	.....do	10,000
3144–5585	538 L....	Enlargement	1,060,000
3144–3483	540 L....	Banquette	50,000
3483–3980	545 L....	.....do	110,000
3980–5585	555 L....	.....do	200,000
			2,580,000

2,580,000 cubic yards, at 15.5 cents=$399,900.

The levee board funds available for construction during the coming season are, as estimated by the secretary and treasurer, approximately $150,000 and $87,000, the first item being obtained as follows:

Revenues:		
Ad valorem tax and acreage	$140,000	
Cotton tax	140,000	
		$280,000
Fixed annual liabilities, salaries, interest on bonds, etc	90,000	
Possible land damages	40,000	
		130,000
Balance available October, 1900		150,000

The second item was obtained in compromise of a back-tax suit from the Yazoo and Mississippi Valley Railroad Company. The total amount was $125,000. Of this, $38,000 was paid in lawyers' fees, leaving an available balance of $87,000. The suit through which this additional fund was received was one against the railroad, as stated, for the recovery of taxes claimed to be due the levee board on lands sold under what was called the 10-cent assessment levied under the act of 1865. The sales were made from 1867 to 1876, and the amount sued for, I am informed by one

he lawyers for the plaintiff, was about $700,000, the exact amount being uncer-, owing to lapse of time, change in title due to purchase, occupation, subsequent slation, etc.

am informed by the chief engineer that it is the purpose of the levee board to end $125,000 of the available $237,000 in the near future, to be distributed roximately as follows:

ions.	Miles below Cairo.	Kind of work.	Yardage.
100..	365 L....	Banquette	40,000
2413..	407 L....	Enlargement	100,000
2520..	416 L....	Banquette	48,000
3163..	432 L....	do	70,000
3852..	459 L....	Enlargement	150,000
3813..	458 L....	Banquette	20,000
225..	482 L....	do	5,000
790..	490 L....	do	27,000
1070..	495 L....	do	35,000
3551.. / 3980..	545 L....	Banquette to 6-foot grade	110,000
Total.			605,000

x hundred and five thousand cubic yards, at about 21 cents, including engineer- etc., = $125,000.[1]

educting this 605,000 from the first statement, there remains 1,975,000 cubic s to be placed, and the necessary repairs to existing levees, maintenance, etc., e covered by the $112,000 levee board reserve, and other funds that may be ted by the United States.

15½ cents per yard the $112,000 levee board reserve should put up about 00 cubic yards, leaving the following amount necessary to bring the line to dard section and 3 feet above the 1897 water:

roximately 1,253,000 cubic yards, at 15½ cents	$194,215
ntenance, repairs, etc., one year	40,000
eplace probable change in grade for sinking, etc	10,000
levees during season 1900–1901	10,200
Total	254,415

his includes but a comparatively small amount for new levees, of which there s to be no imminent need this year, though it is impossible to tell what may be loped by river changes in a very few months. The present indications are that ges at Baleshed and Fitlers will not require at most over $10,200 for temporary x, and Jenkins Front will hardly require any work for a year.

accordance with last year's report, the approximate estimate for the 6-foot e for the entire district for standard levee with banquette was 21,500,000 cubic s. Deducting about 2,800,000 cubic yards for work during the year, and adding ible yardage for sinking, etc., of 100,000 cubic yards, this estimate becomes 00,000.

o to the present time it has been the policy of the commission to complete the es in this district to 3 feet above 1897 water, practically with standard section, re commencing to raise the line to the ultimate grade of 6 feet above the same m or reference line. In the former estimate dikes or spurs have been included, e constructed along the Huntington Short Line at stations indicated. The high- r slope from Stations 3314 to 3600 is 1.3 feet per mile, a drop of about 7 feet e entire distance. The current induced by such a slope will be very destructive e levee unless deflected and kept at a proper distance from it.

SODDING REPAIRS AND WEED CUTTING.

e cost of sodding repairs and weed cutting during the summer of 1899 is given companying table.[2] The need of such extensive sodding was due to the very

[1] his work can be done for less than 14 cents per yard, but as I have been informed he president and the chief engineer of the levee board that the $125,000 will have ver other expenditures not included in this report, even the approximate amount hich they are unable to state, the 605,000 cubic yards at 21 cents is expected to de all these additional items.

[2] mitted.

severe weather in February, 1899, when much of the Bermuda sod north of Ro (Station 1450) was killed.

The sod put in by contract last summer, owing to the very hot and dry seas not live, and it has been necessary to replace it this year. This is being do by hired labor, obtained on the farms along the line at much less expense.

LEVEE MAINTENANCE.

The resolution of the Commission to the effect "That the levees can not be tained in proper condition when used as roadways," etc., and "that no fu applied for levee construction of any kind, until satisfactory evidence has been re * * * that travel and other detrimental use of the levee has ceased," et been to some extent salutary. The board of supervisors have met and in instances provided roads away from the levee, but in many reaches the levee used as a roadway, and hogs root out the sod. The cross fences built by the States have been added to by the levee board, and a more determined effort is made to bring the people living behind the levee to understand the import radical reform in this matter, if the Government is to aid in the constructi maintenance of these works to which they look for protection.

The expenditure of Government funds in this district during the year is gi detail in an accompanying statement,[1] the aggregate amounts being as follows

	Amount.	P
Construction	$308,511.53	
Repairs	15,982.85	
Engineering	18,154.76	
Total	342,649.14	

The statements, drawings, etc., accompanying this report are as follows:

Statement of expenditures.[1]
Statement of rainfall during year.
Statement of construction details.
Statement of construction by levee board.
Statement of condition of levee at present time.[1]
Statement of repairs.[1]
Statement of sodding.[1]
Statement of weed cutting.[1]

Maps[1] of bank line at the following localities: Australia, Waxhaw, Riverton var, Jenkins, Bachelors Bend, Longwood, Leota, Island 92, Baleshed, Shiplan lers to Shiloh, and Albemarle to Brunswick.

Profiles[1] of the district to accompany report, showing high water of 1897, forwarded before the end of the month.

Yours, respectfully,

H. St. L. Coppée,
Assistant Engi

Capt. Chas. L. Potter,
Corps of Engineers, U. S. A.

Rainfall at Greenville, Miss., from May 1, 1899, to May 1, 1900.

Months.	1899-1900.	Mean, 1886-1900.	Months.	1899-1900.	18
1899.	*Inches.*	*Inches.*	1900.	*Inches.*	
May	4.67	3.45	January	1.93	
June	1.41	3.72	February	5.06	
July	2.11	4.34	March	5.74	
August	.88	3.77	April	6.99	
September	1.15	2.79			
October	1.09	1.95	Total	36.26	
November	1.06	3.74			
December	4.22	3.76			

[1] Omitted.

Levee work in Lower Yazoo Levee District, May 1, 1899, to May 1, 1900.

[E.=Enlargement. T.=Topping. N.=New. B.=Banquette.

ations.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
										Cents.	*Ft.*	*Ft.*	
00–2800	419 L..	McCadden & Roach	134,738	11,112	658	401	267	28	42	12.23	16.6	175	E.
29–3360	436 L..	McIntyre & Howard	155,475	12,995	918	611	404	21	32	12.98	18	170	N.
36–3492	443 L..	Government force	9,500	9,500	584	437	295	22	32	21.6	28	500	N. & T.
00–3930	445 L..	Arnold & DeGaris	45,164	36,912	1,975	1,195	749	31	41	16.1	16.4	180	E.
30–4200	459 L..	.....do	50,316	23,233	1,560	925	577	25	40	15.75	19.4	180	E.
00–4500	476 L..	Timothy Sullivan	113,678	25,467	1,044	808	503	32	51	12.95	14.6	200	E.
00– 300	483 L..	H. F. Watkins	65,818	18,837	737	476	318	40	59	10	10.7	180	E.
00– 500	487 L..	J. H. McTighe	59,635	16,325	804	337	226	48	72	12.5	9.4	150	E.
00– 600	489 L..	T. Mike	58,076	47	12	4	2	12	24	8.74	10.4	175	E.
00– 790	492 L..	C. A. Winter	61,122	16,998	1,007	549	392	31	43	13.375	13.2	150	E.
11– 900	492 L..	Jno. C. McIntyre	106,214	62,428	3,837	2,569	1,499	24	42	16.625	17.2	225	E.
11– 980	492 L..	S. C. Bull, jr	76,331	76,331	3,775	2,564	1,790	30	43	14.99	6.4	175	B.
00–1000	493 L..	J. B. Lewis	111,795	13,154	619	399	299	33	44	13.25	16.4	200	E.
00–1100	494 L..	.....do	89,623	30,367	1,916	1,272	842	24	36	11.9	15.3	200	E.
00–1200	495 L..	T. Mike	81,312	38,259	1,579	1,079	717	35	53	9.5	14.7	175	E.
00–1300	497 L..	T. Mike	66,892	39,483	1,834	1,327	861	30	46	9.99	12.8	175	E.& N.
00–1400	499 L..	Robert Johnsen	93,842	36,296	2,684	1,682	981	22	37	14	17	250	E.
00–1500	500 L..	M. McTighe	133,198	44,951	2,526	1,715	1,266	26	36	18	18.1	325	E.
00–1600	502 L..	Jno. C. McIntyre	85,314	22,353	1,256	868	632	26	35	15.375	16.7	200	E.
00–1700	503 L..	Ben Talley	75,109	44,992	2,148	1,346	926	33	49	14	15.8	225	E.
00–1800	504 L..	H. F. Watkins	60,797	43,297	1,890	1,330	898	33	48	11.48	13.1	200	E.
00–1900	505 L..	J. & A. Wynn	67,447	3,495	402	260	154	14	23	10	12.8	200	E.
08–2200	515 L..	Arnold & Co	56,585	56,585	2,435	1,550	999	37	57	14.25	13.9	150	E.
00–2300	516 L..	.....do	52,786	52,786	3,307	2,120	1,488	25	35	14.25	12.6	150	E.
00–2400	517 L..	J. & A. Wynn	67,328	67,328	2,721	1,710	1,181	39	57	12.75	10.5	190	E.
00–2500	527 L..	McCadden & Roach	107,997	107,997	5,368	3,096	2,015	35	54	18.5	13.2	200	E.
00–2600	529 L..	L. C. Dulaney	82,972	82,972	4,502	2,785	1,925	30	43	15.4	13.9	195	E.
00–2700	530 L..	Jas. H. Cary	87,451	87,451	4,340	2,955	2,084	30	42	17	16.9	170	E.
00–2800	531 L..	C. A. Winter	67,160	67,160	3,271	2,172	1,490	31	38	14.125	13.6	190	E.
00–2900	532 L..	S. C. Bull, jr	57,961	57,961	3,098	2,030	1,377	29	42	14	13.2	190	E.
00–3000	533 L..	Gilchrist & Crow	67,989	67,989	2,482	1,745	1,126	38	60	14.5	14.9	160	E.
00–3135	535 L..	L. C. Dulaney	100,705	100,705	5,044	3,263	2,145	38	47	13.74	14.4	175	E.
20–3504	538 L..	Stone & Stansell	31,893	31,893	1,411	971	645	33	49	22	13.7	150	T.
00–3800	550 L..	.....do	33,354	33,354	1,523	972	649	34	51	24	11.3	100	T.
00–4076	552 L..	Jas. H. Cary	32,054	32,054	1,702	1,139	764	28	42	29	13.6	125	T.
78–4133	554 L..	Shippey & Kilpatrick	168,956	74,574	3,655	2,837	1,829	26	41	14.74	13.8	190	N.
33–4188	555 L..	.....do	170,493	115,747	8,157	5,578	2,741	21	42	14.74	13.5	175	N.
88–4243*a*	555 L..	.....do	88,915	27,549	1,604	1,048	658	26	42	14.74	10	160	N.
15–4500	558 L..	J. & A. Wynn	31,481	31,481	1,802	1,190	806	27	39	25	11.3	120	T.
00–5200	565 L..	L. C. Dulaney	58,133	58,133	4,143	2,710	1,802	21	32	24	11.9	165	T.
00–5400	573 L..	Davis & Wood	35,267	35,267	2,026	956	649	37	54	10.75	6.1	85	T.
00–5585	585 L..	S. C. Bull, jr	34,382	34,382	1,928	1,028	730	33	47	14.99	6.1	100	T.

Old enumeration.

Of these two contracts, 143,296 yards placed by United States Government force at a cost of 18.34 cents yard.

Respectfully submitted.

H. St. L. Coppée,
Assistant Engineer.

Greenville, Miss., *May 10, 1900.*

Table showing levee construction by the Mississippi State levee board May 1, 1899, 1900.

[B.=Banquette. D.=Dike extension. T.=Topping. R.=Repairs. E.=Enlargement. S.=Restoring sunken levee.]

Stations.	Miles below Cairo.	Cubic yards in contract.	Cubic yards placed during year.	Price per cubic yard.	Team price per day.	Extras paid.	Total expended
				Cents.			
1100-1150	391 L.	15,621	15,621	12.4			$1,937.0
1380-1512	396 L.	52,117	52,117	13.9			7,244.5
1595-1645	400 L.	209,627	209,627	14.5			30,395.5
1843-1934	402 L.	46,873	46,873	16.4		$8.40	7,792.8
1990-2009							
2009-2233	405 L.	82,342	63,047	14.3			9,429.0
2413-2650	415 L.	189,127	127,399	16 and 26			20,336.8
2913-2976	425 L.	2,672	2,672	20			534.4
2975	425 L.	14,788	14,788	16.75			2,476.9
3121-3145	434 L.	85,463	85,463	14.24			12,169.9
3163-3187	434 L.	135,993	135,993	15.2			20,670.9
3163-3187	434 L.	3,200	3,200		$4.50		607.5
3254 and 3491	457 L.	1,239	1,239		4.50		346.8
4509-4511	476 L.	333	333	24.99			83.3
4245-4252	479 L.	33,261	3,777	21.97			1,827.7
4262-4289							
1929	512 L.	467	467		4.50		96.0
3000-3500	530 L.	4,309	4,309		4.00		1,740.0
3500-3550	530 L.	48,237	44,071	13.5			6,033.5
3220-3321	538 L.	10,651	10,651	22			2,343.2
4750-4890	567 L.	132,837	106,525	12			13,256.6
		163,142	77,456	15			12,046.8
		171,463	47,067	15.4			10,137.3
4750-4890	567 L.	7,601	7,601	24			1,824.2
5335-5400	573 L.	1,215	1,215	10.75			130.6
5400-5437	585 L.	7,065	7,065	14.99			1,059.0
4887-5200							3,878.5
Total							168,400.7

NOTE.—In this table the multiplications in many cases do not agree with the totals, ow fact that in some instances a bonus was given, and in some instances the retained p unpaid; but the totals are supposed to be correct.

Respectfully submitted.

H. ST. L. COPPÉE, *Assistant En*

GREENVILLE, MISS., *May 10, 1900.*

REPORT OF MR. E. C. TOLLINGER, ASSISTANT ENGINEER.

GREENVILLE, MISS., *May 1*

CAPTAIN: I have the honor to submit the following report of operation Upper Tensas Levee district from May 1, 1899, to May 1, 1900:

This district (402 to 606 miles below Cairo) extends from Red Fork, on th sas River, to a point in Louisiana opposite Warrenton, Miss. There is one co line of levees extending from Red Fork to Station 733 on the Arkansas Rive as the Arkansas River system, and another, from Costello's Gin, on Amos B the lower end of the district, known as the Mississippi River system.

Arkansas River system.—This system extends from Red Fork south along th Station 733, a distance of 13.88 miles, 12.4 miles (Stations 0 to 655) being bui United States in 1894 to 1896, and 1.48 miles (Stations 655 to 733) being bui local boards and the United States in 1899 and 1900. These levees were co with the standard section of 8-foot crown and slopes of 1 on 3, and 3 feet a highest water prior to construction, without banquette. Stations 0 to 655 we wards topped to 2½ feet above the high water of 1897. This system sh extended, closing on the Mississippi River system at some point along Cypre or ending on the north bank of that creek, as the district is partly exposed flows from floods occurring in either the Arkansas or Mississippi rivers pa between the two systems of levees.

There is a system of levees on the Arkansas River, extending from the vi Pine Bluff, Jefferson County, along the river to Red Fork, Desha County, a of 57.3 miles, built by private subscription and local boards.

Mississippi River system.—This begins at Costello's Gin, on Amos Bayou, and runs long that bayou 5 miles; thence to the junction of Boggy Bayou and Cypress Creek, .5 miles; thence along Cypress Creek 6.5 miles; thence along the Mississippi River 57.1 miles to the lower end of the district.

The total yardage in the district May 1, 1899, was about 24,724,455 cubic yards, he United States having placed 18,282,416 cubic yards. During the past year there ave been added to the line about 1,553,373 cubic yards paid for by the United tates, and about 784,882 cubic yards paid for by the local boards and State of Loui-iana, divided as follows: In Arkansas, 828,134 cubic yards erected by the United tates and 364,564 cubic yards by local authorities; in Louisiana, 725,239 cubic yards y the United States and 420,318 by local authorities. Total contents of the levees o date, 26,785,610 cubic yards.

The length of line thrown out by the construction of new loops was about 12,418 eet, containing about 277,100 cubic yards.

CONSTRUCTION.

At the close of the annual report of 1899 the following work was under contract:

In Arkansas:
- Stations 420–484 (427 R.).[1]
- Stations 520–605 (429 R.).
- Stations 605–630 (430 R.).
- Stations 630–660 (430 R.).[1]
- Stations 906–931 (438 R.).
- Stations 1080–1200 (441 R.).[2]
- Stations 1200–1240 (442 R.).
- Stations 1780–1810 (466 R.).
- Stations 1810–1941 (466 R.).
- Stations 1942–2047 (468 R.).
- Stations 2740–2850 (490 R.).
- Stations 3065–3100 (496 R.).
- Stations 3100–3160 (496 R.).
- Stations 3400–3500 (505 R.).
- Stations 3500–3600 (506 R.).
- Stations 3600–3700 (508 R.).

In Louisiana:
- Stations 2411–2500 (562 R.).
- Stations 2500–2601 (564 R.).
- Stations 2810–2931 (574 R.).
- Stations 2931–3031 (576 R.).
- Stations 3031–3118 (577 R.).
- Stations 3118–3197 (579 R.).
- Stations 3197–3277 (580 R.).
- Stations 3310–3328 (582 R.).
- Stations 3328–3428 (582 R.).
- Stations 4540–4551 (605 R.).

The suspension of work on the above three contracts and final failure of the contractors were due to heavy rains that continued throughout the season, and locations which could not be drained except at prohibitory cost. These contracts were relet and completed at contract price with retained percentage added.

All the above contracts are now complete except Stations 1200–1240 (442 R.).

Bid opened July 18, 1899.

In Arkansas:
- Stations 0–655 (Ark. R.).
- Stations 2562–2740 (488 R.).
- Stations 2850–3065 (491 R.).
- Stations 3185–3400 (498 R.).

In Louisiana:
- Stations 1679–1725 (545 R.).
- Stations 2368–2411 (562 R.).
- Stations 3763–3840 (591 R.).
- Stations 4507–4540 (604 R.).[3]
- Stations 4551–4570 (605 R.).[3]
- Stations 4570–4619 (605 R.).[4]

All the above contracts are now complete except Stations 4570–4619 (605 R.).

[1] Let August 31, 1897.

[2] Let November 23, 1896.

[3] Awarded to the J. S. McTighe B. C. & I. I. Co. August 11, 1897. The constant rains hroughout the season prevented the contractors moving on the work. These contracts were relet to Maxwell & Nicholson at an advance of 9 cents per cubic yard for he former, and 11.5 cents per cubic yard for the latter over the original price, and n addition to that the Fifth Louisiana Levee district paid Maxwell & Nicholson 3,000 for drainage. This was given as a lump sum to secure drainage without urther claim on either board or the Government, the contractors taking all chances. 'his sum, however, was not sufficient to secure drainage, inasmuch as the bayou mmediately behind the line added materially to the cost. These contracts have een completed.

[4] Arrangement was made under this contract to repair the sliding mentioned in my nnual report of 1899 which had occurred in the work between stations 4540 and 551. This was brought up to grade and slope in January, 1900, and is still standing, ut it is thought that the trouble may recur in case the levee should become saturated y a high water.

Bid opened July 31, 1899.

In Louisiana:
Stations 1303–1363*a* (540 R.).[1] Now complete.

Compared with the records of the Weather Bureau's Annual Report for 1 conditions have been favorable for work throughout the season. The co have made money. Out of a total of 65 contracts by local boards, State aut and the United States, only two remain unfinished.

The established grade of the above work is 3 feet above the high water crown, 8 feet; slopes, 1 on 3.

CONDITION OF LEVEES WITH REFERENCE TO 1897 HIGH WATER.

In Arkansas.—Arkansas River system, 13.88 miles:
Stations 0 to 655, 12.4 miles topped to 2.5 feet above 1897 high water.
Stations 655 to 733, 1.48 miles new levee 3 feet above 1897 high water.
Mississippi River system, 83.3 miles, Costello's Gin to Louisiana State line
55 per cent of line 3 feet above 1897 high water.
31 per cent 1 to 2 feet above 1897 high water.
14 per cent topped to 3 feet above 1897 high water.
28 per cent has banquette.
72 per cent is without banquette.
In Louisiana.—Length of line from Arkansas State line to Bedford, La., 86.
18 per cent 1.6 feet above 1897 high water.
8 per cent 2.2 feet above 1897 high water.
12 per cent 2.6 feet above 1897 high water.
4 per cent 3.6 feet above 1897 high water.
58 per cent 3 feet above 1897 high water.
73½ per cent has banquette with grade generally 5 feet below high water o
26½ per cent has no banquette.

The following work was done under the supervision of the United States, for by the Tensas Basin, Chicot County, Desha County, and Red Fork Levee
Stations 655 to 680 (Arkansas River) let January 16, 1899.
Stations 680 to 707 (Arkansas River) let August 18, 1899.
Stations 707 to 738 (Arkansas River) let August 18, 1899. Part of the cos contract, amounting to $10,182.40, was paid by the United States.

These contracts have been completed.

To provide funds for the above three contracts, at a joint meeting of the R Desha County, Chicot County, and Tensas Basin Levee boards, a resolut passed appropriating $11,000 annually for three consecutive years, beginn 1899. At a subsequent meeting of said boards it was thought best to apply assessments, $33,000, at once in extending the levee across a low depression t ground, thus greatly reducing the flood discharge between the Arkansas an sippi River systems. This amount, $33,000, and the Government allot $10,182.40, making a total of $43,182.40, extended the levee 7,800 linear feet t 733. The Government also topped the line from Stations 0 to 655 at a cost struction of $19,329.66.

In this connection I wish to call your attention to the fact that the combine of the local boards are not sufficient to close this gap in the near future. much encouraged by the Mississippi River Commission being disposed to ai work when funds are available from future allotments. (See tabulated stat expenditures.)

High water of 1900.—The maximum stage up to this date has been excep low, the records at Arkansas City showing, on March 24, 39.2; at Greenvill 25, 33.75. There are only two records of lower water at Arkansas City sin these exceptions being 1889 (June 30), 36.30, and 1895 (April 1), 32.5; and a ville only two records of lower water since 1844, these being in 1889 (July 1 and in 1895 (April 1), 27.7.

[1] This work was awarded to Ernest Hyner at an informal letting, but the c failing to comply with the specifications in regard to time of completion, Fifth Louisiana levee district agreeing to pay the difference in price, 68,0 yards were relet to Goff & McTighe, same costing $3,461.32.

The maximum gauge readings are given for 1897, 1898, 1899, and 1900:

	1897.	1898.	1899.	1900.
ro	51.62	49.78	46.2	39.2
ena	51.75	49.11	46.8	38.1
ansas City	51.9	51.13	48.6	39.2
enville	46.75	56.15	43	33.75
e Providence	44.54	44.85	41.7	32.95
ksburg	52.48	49.4	47.3	38

Information regarding seepage, high-water protection, flood areas, etc., may be tained from 1899 report, there being no additional data, as there has been no high ter so far in 1900.

Relation of Arkansas River and Mississippi River Levee systems.—The Arkansas River ees extend from a point about 12 miles below Pine Bluff to a point about 13.88 les below Red Fork, making about 71 miles of continuous levee, and having a gap tween the present terminus and the Mississippi River system of about 6.83 miles. e levees from Pine Bluff to Red Fork have been built and maintained by the local horities. They are intended to protect the country along the southern bank of Arkansas River. While the country along the entire length of the line is in a h state of cultivation, very fertile, and well improved, the revenues derived for ee purposes are very meager, the only levy for this purpose being 5 mills on lty in Jefferson and Lincoln and 10 mills in Desha County, being annually about 000 in Lincoln County, which has 20 miles of levee front. This sum is entirely dequate for the necessary improvements of the levees, and is usually wasted in es of emergency.

On a reconnaissance of this line it was found that the levees had generally been y inadvertently located, and constructed with a very weak section, without any eparation of base. This was, of course, due in part to scarcity of funds, which uld not admit of any expenditures except for the piling up of earth. In order to ke this country secure from such floods as have been experienced in the past it is imated that it would be necessary to abandon about 50 per cent of the existing ee line, build up on new locations, and raise the entire system, with standard tion, about 2 feet above the present grade, which would be practically 3 feet above ir highest known water, which would require:

	Cubic yards.
r enlargement	451,100
r new levee	1,086,000
r muck ditch, stump holes, etc	322,900
Total	1,860,000

This would cost $200,000.

This amount, properly expended, would insure a good and substantial levee system m the present terminus in Jefferson County to Red Fork, in Desha County.

The 13.88 miles of levee from Red Fork down to the present terminus have been ilt by the United States (the local boards furnishing some funds, itemized elsewhere) with standard section without banquette.

From Stations 0 to 655 was built in 1894 to 1896 to grade of 4½ feet above high ter of 1893. From Stations 655 to 733 was built to the grade of 3 feet above h water of 1897.

The district below the Amos Bayou line is subject to overflow from the water that ers this gap and flows around the head of the Mississippi River system at Costello's n; and the country above the Amos Bayou line is subject to overflow by flood ter flowing in and backing up behind the Arkansas River levees, inundating a t area of fertile, timbered soil.

The area subject to overflow from the above cause can be very materially reduced extending the Arkansas River levees from the present terminus to some point on press Creek, or by extending them to a point on Cypress Creek near the Boggy you Crossing, opposite Station 81 of the main line.

The overflow of the lower part of the district by the flow around the Amos Bayou e could be prevented by extending the Amos Bayou line to high ground, something like 10 miles from the present terminus. This levee would average about 6 t in height, and would require about 500,000 cubic yards. Or, it may be entirely viated by connecting the Arkansas River levees with the Mississippi River levees

at one of the above points. This would close up Cypress Creek, which is outlet for the drainage of a large scope of country lying along and ba Arkansas River, necessitating the opening of Boggy Bayou and diverting t by way of Boggy Bayou, Bayou Maçon and Bouef, Ouachita and Black riv Red River.

While sufficiently detailed surveys have not been made to determine this drainage project, it is believed to be practicable.

On the accompanying blue print the location of the two preliminary li necting the two systems is shown; also the estimated yardage of the sam

To build the front line from Station 733 ("A") (the present terminus of t River levees) to a point about 2.5 miles ("C") above the mouth of Cy would reduce the flood-head, assuming that the flood slope would rema with the levee in position that it was before, affecting the upper part country about 5 feet. While it would only cost about the same for con the Dry Bayou line, it would furnish 1.3 miles more levee for mainte would be exposed to caving on the upper side of Caulks Neck, and wou open gap of about 4 miles between the two systems which would allow tion of all lands, in case of continued flood periods, not relieved by the head, and if it should become necessary to close up this gap it would requ truction of about 4 miles of additional levee, and add to the uncertain caving bend.

To construct a levee from Station 733 ("A") to Station 1087 ("F") Bayou line, a point opposite Station 81 of the main line, would reduce t the same assumption as used above, about 3.4 feet. This line would be and would reduce the gap to about 1,000 feet, and could be conveniently to the main line when desirable.

This, in my opinion, is the best solution of the matter, and subseque ments may prove that it will not be necessary to close this small gap for to come.

SURVEYS.

Preliminary locations.—A survey was made in November and December 733, the lower end of the Arkansas River system, to Station 81 of the ma was continued from the point of divergence, to connect with the main the east bank of Cypress Creek, and connected with the main line belo Fork Crossing, at Station 380.

The line of survey on the front line, which was abandoned on account water the previous January, was taken up and connected by stadia with Lucca Landing.

These surveys have been platted and estimates made of the several lin

Shore line located.—Shore lines have been located at the following pla Bend (426 R.), Elton Front (539 R.), Willow Point (565–575 R.), (585 R.), Duckport (590 R.), Biggs (604 R.), and the probable locati levees that will have to be constructed in the near future. Blue prints sh locations have been forwarded to your office, with the exception of th tioned, which is made a part of this report.

The caving in Cypress Bend has been from 200 to 600 feet in the p months, being 200 feet at Lucca Landing, where it is now within 600 feet At the present rate of caving a new loop will have to be constructed with three years.

Elton Front (539 R.).—This point has been the source of considerab during the last year or two. In view of the rapid and continuous cavi front, the apparent inability to obtain sufficient funds to extend the Lak revetment upstream sufficiently to control the caving, and the probabili to renew the Elton Front levee from Elton (539 R.) to Wilsons Point (53 is becoming more or less endangered along the entire stretch, it was build a short line from a point on Old River, Station 500, to Station 13 just below the upper end of the revetment. There was so much oppos project by the local interests that the commission decided not to unde the new Elton Loop was built instead.

You will find in your office a blue print showing both the location of th Short Line and the loops that would otherwise have to be built, togeth comparative cost of the same and the valuation, taxation, etc., of the l out. Subsequent developments have not been of a nature to convince short line would not have been or would not yet be the proper sol situation.

The line is now endangered at Station 1278. This point, however, is for by the Louisiana State board.

It is probable, unless the revetment is extended this season, that the lower end of e new Elton Loop will be endangered within the next year or two.

Willow Point (565–575 R.).—The blue print of this point, showing the location of e shore line from time to time since 1882 and the levee loops that have been built d lost thereby, gives an idea of the enormous expenditures that have been virtu- y wasted in the temporary work. The caving continues to such an extent and e levee is so much endangered that a new levee will be absolutely necessary this ason, and it is proposed and recommended, in order to obtain something like per- anency, to build one of the two lines indicated on the print.

Line A C G (loop from Stations 2466 to 2717, present line), which is located about 00 feet back from the present shore line, would probably stand for some eight or n years, but there is nothing to indicate that this caving will not continue until this int has assumed a shape similar to that of Leland, Carter's, and Ashbrook necks, d in that case it would be destroyed. This line would throw out about 2,153 acres d would increase the present line about 1¼ miles. Estimated yardage listed below.

ne A C D (short line from Stations 2466 to 2927, present line) would give greater rmanency and decrease the length of the present levee about 4 miles, but would row out about 4,416 acres of land. The first line will probably be adopted on count of local interests.

Cabin Teele (585 R.).—Caving continues at this point. Opposite Station 3550 it is thin 750 feet of the levee, which, according to the rate of caving indicated, might ssibly stand for a couple of years yet; but the safest plan would be to build a loop is season if possible. A proposed loop, which is recommended, is indicated on the ne print.[1] Estimated yardage listed below.

Duckport (590 R.).—The caving along this front, while it has been general, has not en very rapid, and it is probable that the line indicated will not be required this ason. Estimated yardage listed below.

Biggs (604 R.).—Caving continues in this bend and is getting dangerously close to e levee at Stations 4397 to 4420, and it is urgently necessary to construct a loop at is point this season. A proposed line is indicated on the blue print,[1] and some- ing approximating that location is recommended. Estimated yardage is listed low.

Youngs Point to Palmyra Lake (594–620 R.).—A survey has been made from a point ar Youngs Point, Station 4011, to New Carthage, Station 425 of the Fourth dis- ct enumeration, running practically straight and cutting out 20,554 acres of land. his line is about 49,200 feet in length and would contain for levee, banquette, muck tch, and stump holes 3,451,336 cubic yards and would shorten the now existing ne of levee 54,200 feet. If such a line could be built, it would eliminate the dan- rs and difficulties of maintaining the levees along the caving bank above Delta oint and around the Bedford bend below.

Table of work probably required within the next three years.

Stations.	Miles below Cairo.	Cubic yards in—		Total.	Remarks.
		Levee.	Banquette.		
0– 485	427 R.	285,090	36,500	321,590	Lucca Loop.
0– 900	430–438 R.	661,967	81,000	742,987	For the necessities of these see 1899 report.
7–2130	469–485 R.	305,943	40,700	346,643	
6–2792	565 R	1,390,064	195,600	1,585,664	Stations 2792–2717, present line.
4–3565	585 R	175,018	17,495	192,513	Stations 3568–3575, present line.
3–3777	590 R	78,727	5,028	83,755	Stations 3777–3763, present line.
2–4472	604 R	301,300	38,700	340,000	Stations 4472–4456, present line.
Total		3,198,129	415,023	3,613,152	

Of the above the following is necessary the coming season:

Stations.	Miles below Cairo.	Cubic yards in—		Total.
		Levee.	Banquette.	
6–2792	565 R	1,390,064	195,600	1,585,664
8–3565	585 R	175,018	17,495	192,513
2–4472	604 R	301,300	38,700	340,000
Total		1,866,382	251,795	2,118,177

2,118,177 cubic yards, at 16 cents = $338,906.32.

[1] Omitted.

Estimate for extension of the Arkansas River levees.

Stations.	Cubic yards in—		Total.	
	Levee.	Banquette.		
Front line.				
733–1157	1,339,426	190,655	1,530,081	
1157–1370	972,558	139.515	1,112,073	
Total	2,311,984	330,170	2,642,154	
Dry Bayou line.				
733–1087	1,332,235	176,177	1,508,412	
1087–1303	748,127	97,835	845,962	
Total	2,080,362	274,012	2,354,374	

Line A E F, containing 1,508,412 cubic yards, is recommended for c and should receive all available funds not absolutely required for the lo until it is completed. The estimated cost is: 1,508,412 cubic yards, at $256,430.04.

Estimated yardage to bring the entire line to a grade of 3 feet above high wa with standard section.

Stations.	Enlargement.	New levee.	Banquette.	Total.	Remarks.
In Arkansas.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	
0–733	365,490	.....	175,119	540,609	Enlargement of Ark levees.
733–1087	.....	1,332,235	176,177	1,508,412	Extension of Arkansa
0–269	656,883	.....	1,057,143	1,714,026	Amos Bayou.
0–4210					Main line.
	1,022,373	1,332,235	1,408,439	3,763,047	
In Louisiana.					
0–4619	617,618	.....	887,760	1,505,378	
Total	1,639,991	1,332,235	2,296,199	5,268,425	

Estimate for ultimate Commission grade.—This is based on the average he Commission grade at White River and Arkansas City, Arkansas City and Greenville and Lake Providence, and Lake Providence and Vicksburg, a these averages to the local high water along the line between these respe thus giving the following approximate estimates in Arkansas and Louisia

IN ARKANSAS.

Stations.	Kind of work.	Cubic yards.	Price.	Total cost.	Remar
			Cents.		
0–655	Enlargement	1,066,015	18.8	$200,410.82	Arkansas River l
655–733	do	125,998	18.8	23,687.62	Do.
733–1087	New levee	2,099,415	17	356,900.55	Do.
0–1087	Banquette	688,635	12	82,636.20	Do.
		3,980,063	.....	663,635.19	(Station 0=Red 1087 = Boggy line.)
0–269	Enlargement	5,571,023	18.8	1,047,352.32	Amos Bayou line
0–4210					Main line.
600–816	New levee	1,249,279	16	199,884.64	Covers Station 60
2047–2131	do	452,453	16	72,392.48	Covers Station 20
0–269	Banquette	1,778,721	12	213,446.52	
0–4210					
Total	.....	9,051,476	.....	1,533,075.96	

IN LOUISIANA.

9.....	Enlargement.....	6,871,767	18.8	1,291,892.20
9.....	Banquette.....	2,293,336	12	275,200.32
Total	.....	9,165,103	.....	1,567,092.52

verage cost of work, 17 cents per cubic yard.
en per cent added for contingencies.
OTE.—These two tables do not include the work required to put the system from Fork to Pine Bluff, on the Arkansas River, to the respective grades, which k will be necessary for the complete protection of the Upper and Lower Tensas icts.

SUMMARY.

	Cubic yards.
ension and enlargement Arkansas River levees.....	3,980,063
ansas, main line	9,051,476
isiana.....	9,165,103
Total cubic yards	22,196,642
l cost.....	$3,763,803.67

nch marks.—This matter has not received the attention it deserves. Stone ches similar to those used by the Mississippi River Commission should be placed y 5,000 feet along the line of the levees, at a safe distance on the land side. se can be placed in position for about $2.50 each, and would be of a permanent racter. It is claimed by some that the present line has not a location sufficiently nanent to justify said expense, but this is hardly true, inasmuch as the location better, to my mind, than it was fifteen years ago. The benches could be moved nd with little expense where threatened by caving banks.

he marking of every 5,000-foot station, which was first done in Arkansas and is being generally adopted, by placing a post 4 feet long on the land-side slope ut 3 feet out from the crown edge, numbered on opposite sides for convenience of ection, and especially for the engineer officer in charge, who is removed every e or four years, as well as for the information of contractors in looking over ertised work, seems to be generally approved.

rainage.—This important subject is referred to in Annual Report of 1899. It seems e that this matter is of sufficient importance to warrant the taking up of a section, 20 miles of levee, making the necessary surveys, and providing means by which stem can be given a practical trial. This would, with small expense, demonstrate advisability of the scheme, and from the data, if the system be found practicable, stimate can be made for the entire district. The levees constructed to the last le established by the Commission will so increase the hydrostatic pressure during xtreme flood of long duration that the country will be inundated from seepage nearly or quite a mile back from the levee. The benefits that a system of drain- would afford adjacent property would be an inducement to the planters to pro- the right of way, and probably share the cost of construction. The best planters thoroughly in favor of making an exhaustive test of an experimental section.

Vave wash.—The erosive action of the waves on the slope of the levee during heavy ontinued winds in time of flood is a source of great care and expense and fre- ntly of serious apprehension for the safety of the levees. In fact, a few crevasses e been attributed directly to this cause by such eminent engineers as Maj. William ling, M. A. Soc. C. E.

his trouble is not experienced where the levees are located through timber or re there is a strip of brush or timber intervening between the levee and the river. rge percentage of the levee line, however, is located through fields that open on river and in time of flood give a clear expanse of water stretching away from 2 0 miles subject to the unobstructed action of the winds. The effect of wave wash ost strongly felt on enlargement or new levees, such work being usually sodded ate in the season that the grass can not acquire a sufficient growth to protect the osed surface, where it is sometimes known in cases of enlargement to cut into original slope of the levee and remove all of the new material from the point of ck to the crest of the flood water. Where the waves attack the slope, which is ally 3 to 1, they will make a water slope of probably 5 or 6 to 1, which, running er the lesser slope on diverging planes, very rapidly increases the amount of erial displaced as the action progresses.

Various methods of preventing wave wash have been tried, probably, engineer who has passed through a flood period, among which method mentioned the following: 1. Placing a continuous strip of bagging or bu the zone of the levee slope affected by the waves and securing it by peggin ground. 2. Placing sheets of corrugated iron, overlapping longitudinally. ing a bulkhead of boards along the front slope. 4. Securing a floating bo posed of logs chained together, along the levee. The most general met however, is to protect the part of the slope affected with bags filled with ear something after the manner of shingling a roof. Each of these metho expensive and has its objectionable features, and where the extent of the not likely to prove a menace to the actual safety of the levee it would pr better to make no expenditures whatever for protection against wave wa decidedly cheaper to replace the material washed away after the water has

The work of restoring the slope and resodding should be done as soon flood as practicable, in order to allow the new material all the time possibl and the new sod all the advantage of the early season to get well set and good growth before another flood.

The number of linear feet of levees repaired and sodded during the season to 111,000. Of this a little less than 3 per cent of sodding was lost on acco drought.

I believe, and have advocated before, that great good could be done by c a growth of willows and cottonwood along such exposed fronts to break th the waves. Both of these plants are very hardy and have a rapid growth probable that plowing a few furrows and covering up the live trunks of wi cottonwood would be sufficient to build up a living breakwater which wou effective and inexpensive in future levee protection. Any recommendatio Commission might make in this connection would receive consideration local boards.

Foundation.—The muck ditch is probably the best method of exploring th tions for new levees, which can not well receive too careful attention. Th of omitting the muck ditch in the construction of levees through cultivate in my opinion, not warranted, inasmuch as we find logs, stumps, etc., exp the caving banks adjacent to cultivated fields, far below the surface, and worth recording that many of us know of old fields having no surface e the existence of such enemies to the effectiveness of good levees until th pits reveal their presence; and cases are likewise known where old cypr show up ten or more stumps in a section 100 feet in length and 150 feet in

In the process of removing stumps from the levee foundation objectio tures in the foundation very frequently develop; in fact, when the stumps a ous and are grubbed out it affords a very effective means of examining the fo as the entire base is virtually handled to a depth of from 3 to 6 feet.

The method of removing stumps by pulling them up with a stump ma in my opinion, some very objectionable features. For instance, it affords of examining the substrata, and in cases of small stumps and large later larger stumps there is not a sufficient void to admit of proper tamping in In fact, it is a question in my mind whether it would not be better t remain than to have them removed when they can not be properly repl earth. The stump puller is a great labor-saving device for the contractor i pits.

Telephone.—A telephone system extending the entire length of the dis nected with the central offices at Vicksburg and Greenville, would be an adjunct to the proper supervision of the levees, and especially during floo when it might be of vital importance. The Lower Yazoo Levee distri advantages of such a system, which has proven very valuable to the servic

The advantages to be derived from such a service were so much appr T. G. Dabney, chief engineer of the Yazoo-Mississippi Delta Levee district, failing to make arrangements with the different telephone companies to c line along their front a special act of the legislature was obtained gr Board the right to construct a line for themselves, which was subsequentl

I believe that this matter should be taken up officially, in order to a some plan can be devised whereby a good telephone system can be secu district. I have already discussed the matter with the manager of the C Telephone and Telegraph Company, and he is now in correspondence different levee boards with that object in view.

Public roads.—The use of the levee as a general roadway continues to b of considerable annoyance in some localities.

At a meeting of the Commission April 29, 1899, a resolution was pas

t that no Government funds would be allotted for the improvement of the levees re they are used as a public highway. This has had a very wholesome effect on levee boards as well as on the general public. Strong efforts are being made by different boards to provide for roads that up to that time had been on the ban-. There are some places, however, where it would be impracticable to get a location within a reasonable cost; for instance, such places as the Fulton Lake ee, where the swamp water stands along the back slope, while the river water along the front. There are many similar places along the line of the levee.

hief Engineer Dabney, who might be termed a regular "crusader" against any all depredators against the levee interests, sums the matter up as follows:

Another incidental function of the banquette is to afford a place for the public over such ground as would otherwise be impracticable for such use. While would appear to be aside from the proper use of the banquette, there is a good on for it, and that is that throughout most of the extent of our levee line the ic has a vested right in the very ground that is covered by the banquette, and we either allow the use of the banquette for road purposes in such cases or provide ad elsewhere, which latter alternative is in many cases impracticable with onable cost.

am disposed to regard the presence of roadways in close proximity to the base he levee as an unmixed evil, and had a purpose at one time to enter a determined ade against it, but upon some investigation I found that the burden of providing r roads, which would devolve upon the levee interests, would entail so great a as to preclude the scheme. I have therefore yielded to the unavoidable and con- part of every banquette for use as a roadway, taking the precaution to fence off eet of its width next to the levee slope and permitting the public to use the aining 25 feet for a roadway. The building and maintaining of the fence are in e cases done by the local authorities as a condition to concession."

ajor Dabney has, in my opinion, arrived at a very good solution of the matter, his district has the advantage over this one of having banquettes with 40-foot ns, where ours have only 20-foot crowns. There are some very good advantages e derived from having public roads along the line of levee. It simplifies and itates general inspection and weed cutting (which latter should be done twice a), and, in fact, all work pertaining to the construction and maintenance of the e system, and there can be but very little harm to come from them, even where are on the banquette, except in time of flood, when the banquette has become sat- ed by seepage, and at such time its use as roadway should undoubtedly be ontinued.

amage by hogs.—Strong efforts are being made generally by the local authorities revent the levees being damaged by the rooting of hogs, and in all instances re they are found on or in close proximity to the levee they are summarily d, unless their rooting apparatus have been permanently disabled.

formal lettings.—The practice of letting contracts for levee construction without iring contractor to give bond to insure completion of same within the agreed , which practice has been pretty generally followed in this district for the last years, has not proven very satisfactory. It encourages carelessness on the part idders, and it has not infrequently occurred that contractors, owing to sharp petition, would bid without proper knowledge of the work at such a low figure they would afterwards abandon the work after the contract had been awarded em, thus entailing upon the Government the expense and delay of readvertising releting the same.

hink the safest plan is to require a certified check with each bid to insure the ution of the contract, with a good and sufficient bond that will induce an honest t on the part of the contractor to comply with his contract.

sources of the levee boards.—The regular annual incomes of the levee boards for e purposes are as follows:

Fork levee board (about)	$3,500
a County levee board (about)	3,500
ot County levee board (about)	13,000
as Basin levee board (about)	15,300
Louisiana Levee district (about)	138,000
Total	173,300

addition to this there is about a quarter of a million from the State at large isiana) to be distributed among the several districts in Louisiana and frequently sist the boards in Arkansas, and the Tensas Basin levee board annually expend entire fund on the Arkansas levees. The Louisiana districts have issued nearly

their limit of bonds authorized. The Arkansas boards have no authorit bonds, but have borrowed more or less on their warrants, anticipat revenues.

Inclosed in this report will be found a list[1] of expenditures of the Uni statement of work done and funds expended by the Desha County, Chic Tensas Basin, and Fifth Louisiana districts and the State of Louisiana, tabl cost of construction,[1] condition of work at end of fiscal year,[1] and labor Map of a part of Arkansas and Mississippi rivers in separate package.

I wish to thank the local levee boards for prompt and efficient cooper my assistants generally for faithful and thorough performance of duty.

Respectfully submitted.

E. C. TOLLINGER, *Assistant E*

Capt. CHAS. L. POTTER,
Corps of Engineers, U. S. A.

Levee work in Upper Tensas Levee district in Arkansas, May 1, 1899, to May

[E.=Enlargement; T.=Topping; B.=Banquette; N.=New.]

Stations.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.
										Cents.	*Ft.*	*Ft.*
0– 655	Ark. R	J. B. Lewis.....	92,046	92,046	a3,624	2,363	1,593	40	59	21	11	15
655– 680	Ark. R	.....do	80,731	80,731	4,003	2,072	1,403	39	58	14.5	14	20
680– 707	Ark. R	Martin Jennings.	109,051	109,051	5,656	3,948	2,593	28	42	20.36	17	15
707– 738	Ark. R	.....do	71,336	71,336	2,293	1,578	1,138	45	63	13	13	15
420– 484	427 R.	W. M. Bates & Co.	53,331	10,981	655	429	245	25	45	13.5	14	20
520– 605	429 R.	L. C. Dresbach & Bro.	64,817	26,717	b1,027	663	449	40	60	17.93	12	17
605– 630	430 R.	W. M. Forrest....	1,883	1,083	66	45	36	24	30	21	16	40
630– 660	430 R.	J. M. Whitehill ..	43,177	13,277	632	405	265	33	50	12	12	17
906– 931	438 R.	Geo. R. Lacy.....	18,541	5,241	303	211	140	25	37	21.99	10	20
1080–1200	441 R.	J. M. Whitehill ..	106,712	23,297	1,067	717	456	32	50	13.99	12	17
1200–1240	442 R.	W. M. Forrest....	33,000	.....	.....	.....	.....	.....	.....	17.90	12	17
1780–1810	466 R.	Robert Johnsen .	20,722	16,410	774	505	286	32	57	11.99	14	15
1810–1941	466 R.	J. V. Daugherty..	155,905	19,826	1,631	1,045	778	19	25	16	17	30
1942–2047	468 R.	McCadden & Roach.	83,603	44,212	2,035	1,396	903	32	49	14.95	14	22
2562–2740	488 R.	J. B. Lewis.....	16,431	16,431	992	666	419	25	39	24.5	10	17
2740–2850	490 R.	W. R. Lewis & Co.	72,839	23,001	1,316	936	643	25	36	12.96	11	20
2850–3065	491 R.	Lewis & Robertson.	137,491	137,491	6,290	4,632	3,012	30	46	13.74	14	15
3065–3100	496 R.	W. M. Bates & Co.	30,920	5,887	352	238	166	25	36	14	17	30
3100–3160	494 R.	W. M. Bates.....	51,123	13,707	739	510	347	27	40	11	16	25
3185–3400	498 R.	.....do	116,213	116,213	5,288	3,493	2,404	33	48	14	13	15
3400–3500	505 R.	C. A. Winter	71,823	5,962	625	388	299	15	20	13.625	15	30
3500–3600	506 R.	.....do	98,030	61,187	4,333	2,868	1,966	21	31	15	16	30
3600–3700	508 R.	Ben Talley	92,191	57,787	3,236	2,146	1,499	27	39	15	16	30

a 1,581 wheelbarrows.

b 359 wheelbarrows.

Respectfully submitted.

E. C. TOLLINGE
United States Assistant En

GREENVILLE, MISS., *May 1, 1900.*

[1] Omitted.

vee work in Upper Tensas Levee district in Louisiana, May 1, 1899, to May 1, 1900.

[N.=New; E.=Enlargement.]

ions.	Miles below Cairo.	Contractor.	Cubic yards in contract.	Cubic yards placed during year.	Total laborers.	Total teams.	Total scrapers.	Yards per team.	Yards per scraper.	Price per cubic yard.	Average height.	Average haul.	Kind of work.
										Cts.	*Ft.*	*Ft.*	
363 *a*	540 R.	Ernest Hyner	185,040	185,040	7,670	5,304	3,675	35	50	13.75	14	245	N.
725	545 R.	F. L. Maxwell	37,846	37,846	1,520	1,018	686	37	55	16	13	175	E.
411	562 R.	Robert Nicholson	46,426	46,426	4,060	2,448	1,779	19	26	27.5	21	225	E.
500	562 R.	L. Aschaffenburg	100,649	41,606	2,070	1,507	1,106	28	38	15.74	18	245	E.
601	564 R.	W. M. Bates	83,670	37,333	2,550	1,818	1,319	21	28	14	17	180	E.
931	574 R.	J. H. McTighe	98,529	24,664	1,409	957	684	26	36	9.99	15	132	E.
031	576 R.	W. J. Bentley & Co	91,115	37,892	2,197	1,405	965	27	39	18.6	16	179	E.
118	577 R.	Geo. B. Vaughan	67,057	9,999	385	195	133	52	77	8.94	15	150	E.
197	579 R.	W. M. Bates	83,070	58,888	*b*3,255	2,164	1,408	27	42	17	19	200	E.
277	580 R.	A. S. Coltharp	74,441	31,950	1,623	1,100	763	29	42	11.45	18	185	E.
328	582 R.	Geo. B. Vaughan	12,504	12,000	461	849	207	34	58	9.45	14	225	E.
428	582 R.	J. C. Hodge	121,179	47,220	1,787	1,524	968	31	49	12.5	16	225	E.
840	591 R.	H. F. Hodge	50,174	50,174	1,703	1,202	784	42	64	12.94	9	115	E.
540	604 R.	Maxwell & Nicholson	48,244	48,244	4,483	2,535	1,666	19	29	32	20	350	E.
570	604 R.	.....do	13,082	13,082	1,453	947	682	14	19	31	21	400	E.
619	605 R.	.....do	73,827	42,770	3,101	2,163	1,598	20	27	30.5	18	400	E.

b 567 wheelbarrows.

spectfully submitted.

E. C. TOLLINGER,
United States Assistant Engineer.

EENVILLE, MISS., *May 1, 1900.*

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ment of work done in the Upper Tensas Levee district in Arkansas and Louisiana by Red Fork, Desha County, Chicot County, Tensas Basin, and Fifth Louisiana levee rds and the State of Louisiana, from May 1, 1899, to May 1, 1900.

WORK DONE IN ARKANSAS.

	Cubic yards.	Cost.
ns 655–680, Arkansas River:		
nsas Basin levee board	34,483	$4,999.98
icot County levee board	20,691	3,060.07
sha County levee board	6,897	1,000.02
d Fork levee board	18,660	2,705.93
ns 680–707, Arkansas River:		
nsas Basin levee board	49,116	9,999.96
icot County levee board	14,735	3,000.00
d Fork levee board	16,179	3,294.10
ns 707–738, Arkansas River:		
sha County levee board	15,384	2,000.00
icot County levee board	23,078	3,000.00
ns 905–930, 438 R.:		
sha County levee board	*a*5,241	1,673.20
ns 345–420, 677–710, 785–798, 798–897, 1040–1080:		
nsas Basin levee board	140,303	23,782.31
ns 2047–2147, 468 R. (topping):		
nsas Basin levee board	9,901	2,437.88
icot County levee board	9,896	2,437.13
laneous expenses in Desha County:		
sha County levee board	.....	1,377.40
nsas Basin levee board (weed cutting)	.....	315.30
laneous expenses in Chicot County:		
icot County levee board	.....	4,550.97
Total	364,564	69,574.25

a Includes $520.70 extra work and damages.

WORK DONE IN LOUISIANA.

and Fifth Louisiana levee board	420,318	$60,466.31

Statement of work done in the Upper Tensas Levee district—Continued.

RECAPITULATION.

	Cubic yards.
Red Fork levee board	34,839
Desha County levee board	27,522
Chicot County levee board	68,400
Tensas Basin levee board	233,803
State and Fifth Louisiana levee board	420,318
Total	784,882
In addition to the above the Red Fork levee board placed above Red Fork	32,410

Cost of work done by the United States in the Lower Yazoo Levee district from May 1, 1900.

Stations.	Miles below Cairo.	Contractor.	Cubic yards.
		Levee construction 1882 to May 1, 1899	13,949,268
		Levee construction May 1, 1899, to May 1, 1900:	
2700–2800	419 L	McCadden & Roach	11,112
3329–3360	436 L	McIntyre & Howard	12,995
3880–3930	445 L	Arnold & De Garis	36,912
4150–4200	459 L	....do	28,233
4400–4500	476 L	Timothy Sullivan	25,467
200– 300	483 L	H. F. Watkins	18,837
400– 500	487 L	J. H. McTighe	16,325
500– 600	489 L	T. Mike	47
700– 790	492 L	C. A. Winter	16,998
811– 900	492 L	John C McIntyre	62,428
900–1000	493 L	J. B. Lewis	13,154
1000–1100	495 L	....do	30,367
1100–1200	495 L	T. Mike	38,259
1200–1300	497 L	....do	39,483
1300–1400	499 L	Robert Johnsen	35,936
1400–1500	500 L	M. McTighe	44,951
1500–1600	502 L	John C. McIntyre	22,353
1600–1700	503 L	Ben Talley	44,992
1700–1800	504 L	H. F. Watkins	43,297
1800–1900	505 L	J. & A. Wynn	3,495
2400–2571	527 L	J. E. Kerr	
4078–4133	554 L	Shippey & Kilpatrick	74,574
4133–4243 *a*	555 L	....do	143,296
811– 980	492 L	S. C. Bull, jr	76,331
2108–2200	515 L	Arnold & Co	56,585
2200–2300	516 L	....do	52,786
2300–2400	517 L	J. & A. Wynn	67,328
2400–2500	527 L	McCadden & Roach	107,997
2500–2600	529 L	L. C. Dulaney	82,972
2600–2700	530 L	Jas. H. Cary	87,451
2700–2800	531 L	C. A. Winter	67,160
2800–2900	532 L	S. C. Bull, jr	57,961
2900–3000	533 L	Gilchrist & Crow	67,989
3000–3135	535 L	L. C. Dulaney	100,705
3220–3504	538 L	Stone & Stansell	31,893
3600–3800	550 L	....do	33,354
3800–4076	552 L	Jas. H. Cary	32,054
4215–4500	558 L	J. & A. Wynn	31,481
4500–5200	565 L	L. C. Dulaney	58,133
5200–5400	573 L	Davis & Wood	35,267
5400–5585	585 L	S. C. Bull, jr	34,382
		Total construction May 1, 1899, to May 1, 1900	1,840,340
		Total construction 1882 to May 1, 1900	15,789,608
		High-water protection, repairs, and engineering expenses 1882 to May 1, 1899	
		High-water protection, repairs, and engineering expenses May 1, 1899, to May 1, 1900	
		Total high water protection, repairs and engineering expenses, 1882 to May 1, 1900	
		Total cost 1882 to May 1, 1900	

b In last year's report this was given as
But there were included liabilities not paid, amounting to

Deducting these liabilities paid this year gives

NOTE.—All work in this district was completed prior to May 1, 1900.

of work done by the United States in the Upper Tensas Levee District from 1882 to May 1, 1900.

ons.	Miles below Cairo.	Contractor.	Cubic yards.	Cost.
		Levee construction 1882 to May 1, 1899	18,282,416	b2,983,521.61
		Levee construction May 1, 1899, to May 1, 1900:		
		Arkansas:		
484	427 R	W. M. Bates & Co	11,048	2,143.02
605	429 R	L. C. Dresbach & Bro	26,700	5,602.58
630	430 R	Wm. M. Forrest	1,073	225.33
660	430 R	J. M. Whitehill	13,230	2,188.18
931	438 R	Geo. R. Lacy		(c)
200	441 R	J. M. Whitehill	22,633	4,309.95
240	442 R	Wm. M. Forrest		(d)
810	466 R	Robert Johnsen	16,410	2,484.57
941	466 R	J. V. Daugherty	19,826	6,924.32
047	468 R	McCadden & Roach	44,212	7,232.89
740	488 R	J. B. Lewis	16,431	4,025.60
850	490 R	W. R. Lewis & Co	23,001	3,634.77
065	491 R	Lewis & Robertson	137,491	18,891.26
100	496 R	W. M. Bates & Co	5,887	1,174.64
160	496 R	W. M. Bates	13,707	2,006.37
400	498 R	Do	116,213	16,269.82
500	505 R	C. A. Winter	5,962	1,774.42
600	506 R	Do	61,187	9,754.05
700	508 R	Ben Talley	57,787	9,316.55
655	Ark. R	J. B. Lewis	92,046	13,929.66
707	do	Martin Jennings	29,022	5,908.72
738	do	Do	32,875	4,273.69
			746,741	122,070.39
		Louisiana:		
363 *a*	540 R	Ernest Hyner	175,040	24,068.00
725	545 R	F. L. Maxwell	37,846	6,055.36
411	562 R	Robert Nicholson	46,426	12,767.15
500	562 R	L. Aschaffenburg	41,606	7,600.94
601	564 R	W. M. Bates	37,333	6,128.35
931	574 R	J. H. McTighe	24,664	3,261.63
031	576 R	W. J. Bentley & Co	37,892	8,408.81
118	577 R	Geo. B. Vaughan	9,999	1,419.54
197	579 R	W. M. Bates	58,888	10,536.65
277	580 R	A. S. Coltharp	31,950	4,174.99
428	582 R	J. C. Hodge	47,220	6,858.05
840	591 R	Harry F. Hodge	50,174	6,492.51
540	604 R	Maxwell & Nicholson	48,244	15,438.08
551	605 R	Arnold, De Garis & Co	10,153	7,158.73
570	605 R	J. S. McTighe B. C. & I. I. Co		*e*319.30
570	605 R	Maxwell & Nicholson	13,082	4,055.42
619	605 R	Do	33,340	*f*9,151.83
			703,857	133,895.34
		Total construction May 1, 1899, to May 1, 1900	1,450,598	256,965.73
		Total construction 1882, to May 1, 1900	19,733,014	3,239,487.34
		High-water protection, repairs, and engineering expenses 1882, to May 1, 1899		*g*650,106.91
		High-water protection, repairs, and engineering expenses May 1, 1899, to May 1, 1900		55,268.05
		Total high-water protection, repairs, and engineering expenses 1882 to May 1, 1900		705,374.96
		Total cost 1882 to May 1, 1900		3,944,862.30

creased $37,992.50 on account of liabilities paid and included in above amounts.
nished by Desha County, Levee Board.
work done. Same as last report.
yment on previous yardage reported.
finished.
creased $4,230.53 on account of liabilities paid and included in amount charged to "High-protection, repairs, and engineering expenses" for year 1900.

Financial statement.

ASHBROOK NECK.

Balance unexpended June 30, 1899	$6
Allotted during current fiscal year	40,0
	40,6
Expended to June 30, 1900	33,5
Balance unexpended June 30, 1900 (in hand and available)	7,1
Expenditures apportioned:	
Material for construction	16,6
Labor on construction	12,6
Cost and care of plant, outfit, and supplies	
Towage and steamer expenses	1,0
Administration and office expenses	8
Subsistence	2,3
	33,5
Amount that can be profitably expended during fiscal year ending June 30, 1902	90,0

GREENVILLE, MISS.

Balance unexpended June 30, 1899	$4
Allotted during current fiscal year	76,0
	76,4
Expended to June 30, 1900	47,6
Balance unexpended June 30, 1900	28,7
In Treasury	25,0
In hand	3,7
Available balance	28,7
Expenditures apportioned:	
Construction of barges	15,1
Material for mattress construction	11,7
Labor on construction	11,5
Cost and care of plant, outfit, and repairs	4,1
Towage and steamer expenses	2,7
Administration and office expenses	1,0
Subsistence	
	47,0
Amount that can be profitably expended during fiscal year ending June 30, 1902	60,0

LAKE PROVIDENCE REACH.

Balance unexpended June 30, 1899	$6
Allotted during current fiscal year	60,0
	60,6
Expended to June 30, 1900	60,6
Balance unexpended June 30, 1900 (in hand and available)	

enditures apportioned:	
Material for construction	$32,803.85
Labor on construction	17,844.53
Cost and care of plant, repairs, and outfit	1,527.23
Towage and steamer expenses	1,733.05
Administration and office expenses	1,625.49
Subsistence	5,337.79
	60,871.94
unt that can be profitably expended during fiscal year ending June 1902	240,000.00

DELTA POINT.

nce unexpended June 30, 1899	$40,662.51
ended to June 30, 1900	40,662.51
enditures apportioned:	
Material for construction	23,857.88
Labor on construction	9,618.95
Cost and care of plant, repairs, and outfit	1,288.49
Towage and steamer expenses	2,682.60
Administration and office expenses	683.02
Subsistence	2,531.57
	40,662.51
unt that can be profitably expended during fiscal year ending June 1902	120,000.00

LOWER YAZOO LEVEE DISTRICT.

nce unexpended June 30, 1899	$107,720.21
ted during current fiscal year	247,000.00
	354,720.21
ended to June 30, 1900	337,171.42
Balance unexpended June 30, 1900	17,548.79
reasury	12,298.50
and	5,250.29
	17,548.79
unt covered by existing contracts and liabilities	5,548.79
Available balance June 30, 1900	12,000.00
enditures apportioned:	
Levee construction	300,309.97
Engineering and office expenses, high-water protection, and repairs	36,861.45
	337,171.42
unt that can be profitably expended during fiscal year ending June 1902	300,000.00

UPPER TENSAS LEVEE DISTRICT.

nce unexpended June 30, 1899	$141,495.46
ted during current fiscal year	197,600.00
	339,095.46
nded during current fiscal year	302,506.04
Balance unexpended June 30, 1900	36,589.42

In Treasury .....
In hand .....

Amount covered by existing contracts and liabilities .....

Available balance June 30, 1900 .....

Expenditures apportioned:
Levee construction .....
Engineering and office expenses, high-water protection, and repairs.

Amount that can be profitably expended during fiscal year ending June 30, 1902 .....

SURVEYS, GAUGES AND OBSERVATIONS.

Allotted during fiscal year ending June 30, 1900 .....
Expended during current fiscal year .....

Balance unexpended June 30, 1900 (in hand and available) ....

Expenditures apportioned:
Pay rolls .....
Material and stationery .....
Administration and office expense .....
Subsistence .....

Amount that can be profitably expended during fiscal year ending June 30, 1902 .....

PLANT.

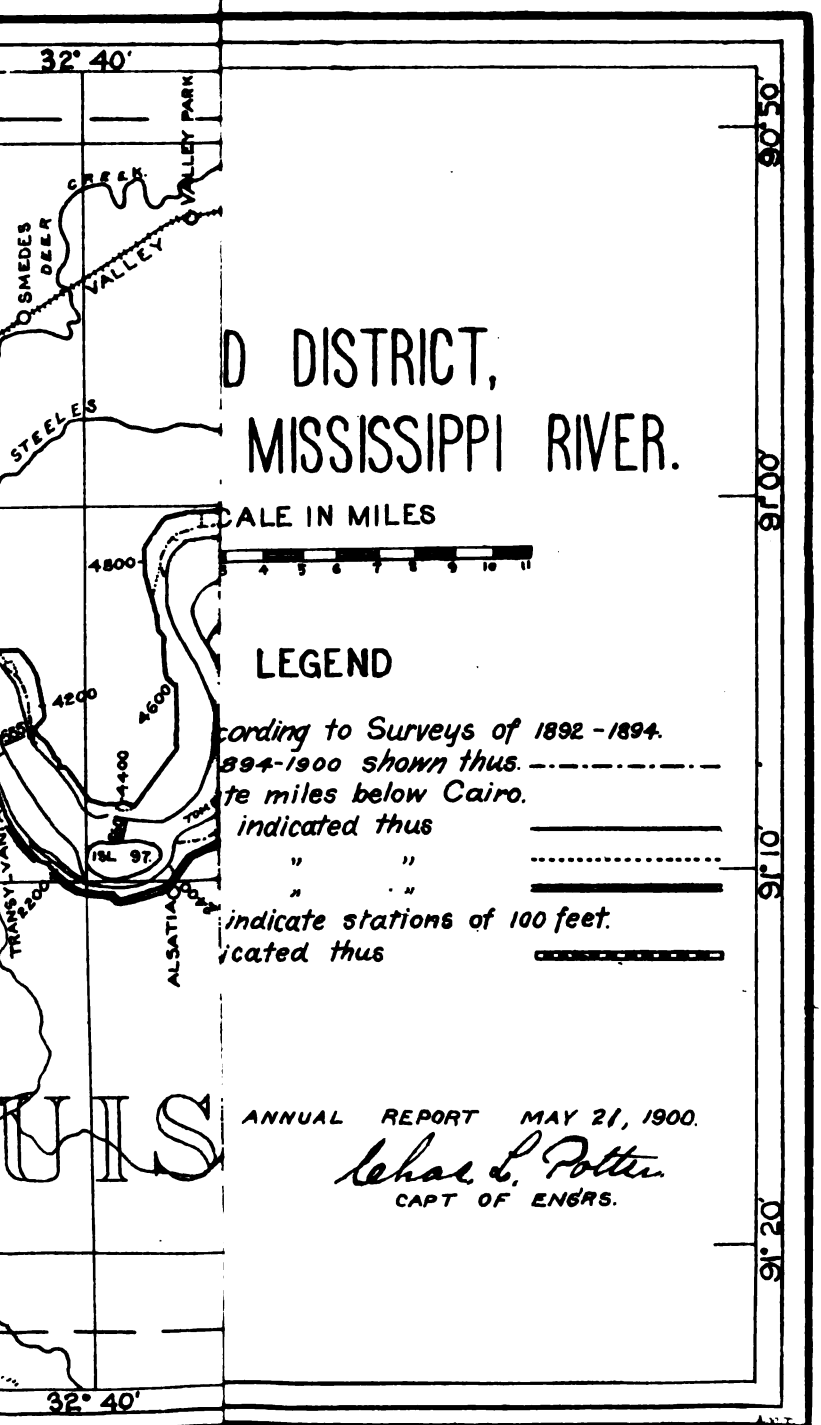
Balance unexpended June 30, 1899 .....
Allotted during current fiscal year .....

Expended to June 30, 1900 .....

Balance unexpended June 30, 1900 .....
On hand and covered by outstanding liabilities .....

Expenditures apportioned:
Construction of barges .....
Material for repairs, outfit, and supplies .....
Labor on repairs and care of plant .....
Administration and office expense .....
Subsistence .....

Amount that can be profitably expended during fiscal year ending June 30, 1902 .....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ANNUAL REPORT MAY 21, 1900.
Chas L. Potter
CAPT OF ENGRS.

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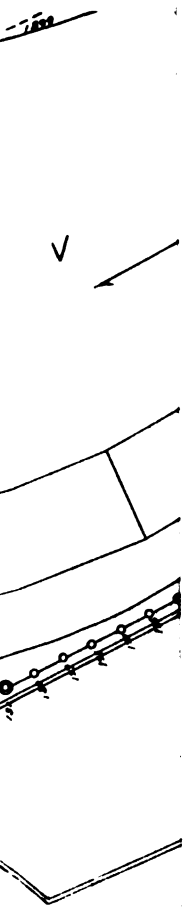
V

Shore
Line
Line

Abstract of informal proposals for levee work in Lower Yazoo Levee district below Greenville received and opened by Capt. H. C. Newcomer, Corps of Engineers, July 18, 1899.

No.	Name of bidder.	Station 811 to 980 (492 L.).	Station 2108 to 2200 (515 L.).	Station 2200 to 2300 (516 L.).	Station 2300 to 2400 (517 L.).	Station 2400 to 2500 (527 L.).	Station 2500 to 2600 (529 L.).	Station 2600 to 2700 (530 L.).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	J. & A. Wynn	.....	.....	.....	a 12.75	.....	16.75	17.25
5	John C. McIntyre	23.37	.....	.....	.....	.....	.....	.....
7	J. B. Lewis	24.75	17	16	13.5	24.75	16	24.5
8	H. F. Watkins	.....	22	22	22	.....	.....	.....
9	Thomas Bros	.....	14.75	15	14	23	18	.....
11	C. A. Winter	17.97	.....	15.87	17.87	17.87	17.87	18.37
12	W. M. Bates	24	17	18	15.99	25	25	25
13	Robt. Johnsen	.....	.....	19.9	19.9	19.9	19.9	19.9
14	McCadden & Roach	18.5	15.5	15.5	14.5	a 18.5	18.5	18.5
15	Jas. H. Cary	18.5	18	18	18	20	17	a 17
16	Ernest Hyner	.....	17	15	18	22	16.5	18
17	J. H. McTighe	.....	.....	19.21	.....	.....	.....	.....
20	Gilchrist & Crow	.....	.....	.....	14.75	27.5	18.5	.....
21	J. D. Van Meter	.....	18.7	17.7	14.1	.....	.....	.....
22	Chas. T. Worthington	17	17.75	17.75	.....	.....	.....	.....
25	S. C. Bull, jr	a 14.99	.....	.....	.....	.....	.....	.....
32	Jno. G. Sessions	22	15.95	15.95	16.95	.....	.....	.....
36	Aderholdt & Lowrance	.....	14.5	14.5	13.25	22.5	17	18
37	Arnold & Co	25	a 14.25	a 14.25	12.95	22.37	16.9	17.9
39	L. C. Dulaney	.....	.....	17	13.6	21	a 15.4	17.95
41	Green Clay	.....	17.5	16	15	.....	.....	19

No.	Name of bidder.	Station 2700 to 2800 (531 L.).	Station 2800 to 2900 (532 L.).	Station 2900 to 3000 (533 L.).	Station 3000 to 3135 (535 L.).	Station 3220 to 3504 (538 L.).	Station 3600 to 3800 (550 L.).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	J. & A. Wynn	15	16.35	17	18.6	30	35
4	Stone & Stansell	.....	.....	.....	15	a 22	a 24
7	J. B. Lewis	15	16.5	17.5	19	.....	.....
11	C. A. Winter	a 14.12	17.62	.....	.....	.....	.....
12	W. M. Bates	18	16	18	18	.....	.....
13	Robert Johnsen	19.9	19.9	19.9	19.9	29.9	29.9
14	McCadden & Roach	16.5	16.5	17.5	15.5	.....	.....
15	Jas. H. Cary	17	15.5	15.5	15.5	29	29
16	Ernest Hyner	16	16	16	15	.....	.....
17	J. H. McTighe	18.74	18.74	23.74	22.78	.....	.....
20	Gilchrist & Crow	15	16	a 14.5	.....	.....	.....
21	J. D. Van Meter	14.25	17.7	17.25	15.48	31.5	30.5
24	Collins & Slocum	.....	.....	.....	.....	27	.....
25	S. C. Bull, jr	.....	a 14	.....	.....	.....	.....
32	Jno. G. Sessions	.....	.....	.....	17	.....	.....
36	Aderholdt & Lowrance	15.75	16.75	18.75	19	.....	.....
37	Arnold & Co	15.5	16.5	18.5	18.9	.....	.....
39	L. C. Dulaney	14.28	16.97	15.21	a 13.74	30	27
41	Green Clay	16	15	14.9	14.7	.....	.....

No.	Name of bidder.	Station 3800 to 4076 (562 L.).	Station 4215 to 4500 (558 L.).	Station 4500 to 4750 (565 L.).	Station 4887 to 5200 (570 L.).	Station 5200 to 5400 (573 L.).	Station 5400 to 5585 (585 L.).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	J. & A. Wynn	45	a 25	27.5	.....	15	15
4	Stone & Stansell	24.94	24.94	24.94	b 24.94	24.94	24.94
11	C. A. Winter	.....	.....	.....	.....	14.87	14.87
13	Robert Johnsen	29.9	29.9	29.9	b 29.9	29.9	29.9
15	Jas. H. Cary	a 29	29	29	b 29	29	29
21	J. D. Van Meter	32.5	.....	.....	b 29.5	27.5	28.5
25	S. C. Bull, jr	.....	.....	.....	.....	14.99	a 14.99
35	Davis & Wood	.....	.....	.....	.....	a 10.75	.....
39	L. C. Dulaney	30	26	a 24	b 32	16	17

a Accepted.
b All bids rejected. Work done under contract of L. C. Dulaney, Station 4500 to 4750, at contract price for latter.

Abstract of informal proposals for levee work in Upper Tensas Levee district in sas, received and opened by Capt. H. C. Newcomer, Corps of Engineers, July 18

No.	Name of bidder.	Station 0 to 655 (Ark. R.).	Station 680 to 707 (Ark. R.).	Station 2562 to 2740 (488 R.).	Station 2850 to 3065 (491 R.).
		Cents.	*Cents.*	*Cents.*	*Cents.*
4	Stone & Stansell	.....	17	.....	15
6	John S. McTighe	.....	.....	.....	15.5
7	J. B. Lewis	a 21	17.4	a 24.5	16.4
8	H. F. Watkins	27.99	.....	.....	.....
11	C. A. Winter	.....	.....	.....	17.49
12	W. M. Bates	.....	27	26	15
14	McCadden & Roach	.....	.....	.....	19.5
15	Jas. H. Cary	.....	.....	.....	15
17	J. H. McTighe	.....	.....	.....	16.25
23	B. A. Stephany	.....	.....	31.99	.....
26	C. O. Greenlee	27	b 13.78	25.68	.....
27	J. H. Bryan	34.99	17.99	.....	15.95
31	Thompson & Powell	22	.....	.....	.....
33	Lacy & Whitehill	29	.....	27.5	20.99
37	Arnold & Co	25	24	.....	.....
38	Lewis & Robertson	.....	.....	.....	a 13.74
40	Geo. B. Vaughan	.....	.....	27.4	14.98

No.	Name of bidder.	Station 1679 to 1725 (545 R.).	Station 2368 to 2411 (562 R.).	Station 3763 to 3840 (591 R.).	Station 4507 to 4540 (604 R.).	Station 4551 to 4570 (605 R.).
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
2	M. McTighe	17	33	14.75	.....	.....
3	F. L. Maxwell	a 16	.....	.....	.....	.....
6	John S. McTighe	.....	.....	.....	38	35
10	J. G. Boney	.....	.....	14.48	.....	.....
16	Ernest Hyner	.....	.....	.....	39	39
17	J. H. McTighe	.....	28.74	.....	.....	.....
18	Maxwell & Nicholson	.....	.....	.....	a 32	a 31
19	Robt. Nicholson	.....	a 27.5	.....	.....	.....
27	J. H. Bryan	.....	.....	14.99	.....	.....
28	Harry F. Hodge	.....	.....	a 12.94	.....	.....
29	L. Aschaffenburg	16.7	29.45	.....	.....	.....
30	Alston & Doran	17.5	.....	14	.....	.....
34	M. P. Erwin	16.4	.....	.....	.....	.....
38	Lewis & Robertson	.....	.....	.....	39.24	39.24
40	Geo. B. Vaughan	.....	.....	14.98	.....	.....

a Accepted.
b Bidder refused to do the work. Relet August 18, 1899.

Abstract of informal proposals for levee work in Upper Tensas Levee district in L received and opened by Capt. H. C. Newcomer, Corps of Engineers, July 31,

No.	Name of bidder.	Stations 1303–1363 a (540 R.).	No.	Name of bidder.
		Cents.		
1	M. P. Erwin	16.7	6	Robt. Nicholson & Co
2	T. B. Davis	17.98	7	John S. McTighe
3	Ernest Hyner	b 13.75	8	J. H. Bryan
4	McCadden & Roach	17.4	9	L. Aschaffenburg
5	Robt. Johnsen	17.7	10	Herron, O'Connor & McLaughlin.

b Accepted.

Abstract of informal proposals for levee work in the Upper Tensas Levee district on Arkansas River, received in response to advertisement of July 28, 1899, and opened at 12 o'clock, August 12, 1899, by Capt. H. C. Newcomer, Corps of Engineers.

No.	Name of bidder.	Stations 680–707 (18.5 miles below Red Fork).	Stations 707–738 (18.5 miles below Red Fork).
		Cents.	*Cents.*
1	John S. McTighe	28	19
2	J. B. Lewis	21	16.4
3	J. H. Bryan & Co		16.99
4	Martin Jennings	17	17

All bids rejected. Work let August 18, 1899.

Abstract of informal proposals for levee work in the Upper Tensas Levee district on Arkansas River, received in response to advertisement of August 14, 1899, and opened at 12 o'clock noon, August 18, 1899, by Capt. H. C. Newcomer, Corps of Engineers.

No.	Name of bidder.	Stations 680–707 (18.5 miles below Red Fork).	Stations 707–738 (18.5 miles below Red Fork).
		Cents.	*Cents.*
1	Stone & Stansell	16.48	16.48
2	Jno. S. & J. H. McTighe	17.5	15.25
3	Martin Jennings	a 20.36	a 13

a Accepted.

Of the total cost of these two pieces of work, $10,182.41 paid by the United States, the remainder by the local boards.

Abstract of informal proposals for levee work in Lower Yazoo Levee district, received and opened by Capt. H. C. Newcomer, Corps of Engineers, September 8, 1899.

No.	Name of bidder.	Stations 4133–4188 (555 L.).	Stations 4188–4243 a (555 L.).
		Cents.	*Cents.*
1	Goff & McTighe	27.4	27.4
2	J. H. McTighe	31.4	31.4
3	Sessions & Dulaney	25.9	28
4	J. & A. Wynn		25
5	McCadden & Roach	24.9	24.9

All bids rejected. Work let September 22, 1899.

Abstract of informal proposals for levee work in Lower Yazoo Levee district, received and opened by Capt. H. C. Newcomer, Corps of Engineers, September 22, 1899.

No.	Name of bidder.	Price per cubic yard.		Stations 4133 to 4243 *a* (555 L.).	
		Stations 4133–4188 (555 L.).	Stations 4188–4243*a* (555 L.).	Price per team per day.	Will furnish.
		Cents.	*Cents.*		*Teams.*
1	McCadden & Roach	24.95	24.95	$5.70	90
2	J. & A. Wynn	.....	22	4.75	25
3	C. B. Smith & Co	.....	.....	5.75	20
4	Sessions & Dulaney	25.75	24	*b* 4.47	80

b Accepted.

List of assistant engineers employed on work of river and harbor improvement, in charge of Capt. Charles L. Potter, Corps of Engineers, from June 30, 1899, to June 30, 1900, inclusive, under the acts approved July 1, 1898, and March 3, 1899.

Residence.	Time employed.	Compensation per month.	Where employed.	Work on which employed.
	Months.			
Arthur Hider, Greenville, Miss.	12	$250	Greenville, Miss	Care and repairs to plant, construction of mattress and material barges, and repairs to revetment works.
E. C. Tollinger, Greenville, Miss.	12	200	.....do	Construction and repairs of levees in Upper Tensas district.
H. St. L. Coppée, Greenville, Miss.	12	200	.....do	Construction and repairs of levees in Lower Yazoo district.

APPENDIX 5.

REPORT OF MAJ. GEO. MCC. DERBY, CORPS OF ENGINEERS, ON OPERATIONS IN THE FOURTH DISTRICT.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., June 1, 1900.

COLONEL: I have the honor to submit the following report upon the work of the Fourth district, Mississippi River Improvement, for the period from June 1, 1899, to June 1, 1900.

The Fourth district, Mississippi River Improvement, extends from Warrenton, 7½ miles below Vicksburg, to the Head of the Passes, about 13 miles from the Gulf of Mexico, a distance of 452.8 miles by river.

The works include the improvement of the harbors at Natchez and Vidalia, Mississippi and Louisiana; improvements at the junction of the Mississippi, Red, and Atchafalaya rivers; improvement of the harbor at New Orleans, La.; bank protection in Bondurant Chute; bank protection in Kempe Bend; dredging of the bars in the Mississippi River below Natchez; and the construction, repair, and maintenance of a portion of the levee system of the district.

HARBORS OF NATCHEZ AND VIDALIA.

The project for this work contemplates the construction of a levee on or near the axis of Cowpen Neck, to prevent flow of water across the neck during high stages of the river, and the construction of about 16,000 linear feet of bank revetment in Giles Bend; estimated cost, $541,300. The object of the proposed work is to prevent the formation of a threatened cut-off at Cowpen Neck, which would cause the destruction of the town of Vidalia, much injury to the water front and landing at Natchez, and increased caving of the banks for many miles above and below, with consequent destruction of expensive parts of the levee system.

The amount expended upon this project to June 30, 1899, was $268,978.82, and there remained a balance of $123,273.22.

During the current year two mattresses were sunk in each of the intervals between the spurs below No. 3, and the upper bank was paved to a height of about 10 feet above ordinary low water. Work was suspended on Jannary 30, 1900, pending the action of another high water in scouring back the upper part of the bank to a slope sufficiently flat to hold a pavement. During the year 1,189,765 square feet of mats were constructed and towed from the willow bar at Bondurant and sunk upon the bank at a field cost of $0.06565 per square foot. The details of the work accomplished are fully described in the appended report of my assistant, Mr. H. S. Douglas. A sketch is herewith showing the location of the work done and the rate of caying of the bank.

The levee on Cowpen Neck is still intact, but it is probable that it will be breached by the caving bank before or during the next high water.

In this connection it should be observed that the revetment work in Giles Bend has not yet reached the narrowest part of Cowpen Neck, and that a further appropriation is needed to prolong the revetment past this narrow part of the neck; until this is done the money already allotted will have produced no useful effect.

The amount expended from June 30, 189 , to June 30, 1900, is $5,580.67, distributed as follows:

Office expenses (main office)		$166.34
Other administrative expenses		971.41
Construction of revetment (hired labor):		
Materials	$558.62	
Wages	2,035.38	
Subsistence	768.12	
		3,362.12
Repairs to plant		379.37
Care of plant		692.93
Miscellaneous		8.50
Total		5,580.67

Money statement.

IMPROVING HARBORS AT NATCHEZ AND VIDALIA, MISSISSIPPI AND LOUISIANA.

July 1, 1899, balance unexpended	$50,000.00
June 30, 1900, amount expended during fiscal year	5,580.67
July 1, 1900, balance unexpended	44,419.33
July 1, 1900, outstanding liabilities	718.85
July 1, 1900, balance available	43,700.48
Amount (estimated) required for completion of existing project	150,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1902	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.

PREVENTION OF CUT-OFF AT GILES BEND, MISS.

The amount expended from June 30, 1899, to June 30, 1900, is $73,273.22, distributed as follows:

Office expenses (main office)		$1,831.76
Other administrative expenses		3,873.76
Construction of revetment (hired labor):		
Materials	$11,046.16	
Wages	37,865.45	
Subsistence	12,601.09	
		61,512.70

Surveys	$876.81
Repairs to plant	1,291.78
Care of plant	2,229.78
New plant	1,388.98
Miscellaneous	267.65
Total	73,273.22

Money statement.

July 1, 1899, balance unexpended	$73,273.22
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900	150,000.00
	223,273.22
June 30, 1900, amount expended during fiscal year	73,273.22
July 1, 1900, balance unexpended	150,000.00

JUNCTION OF THE MISSISSIPPI, RED, AND ATCHAFALAYA RIVERS, LOUISIANA.

A detailed description of the difficulties in this vicinity which the improvements are designed to rectify will be found in the Annual Report for 1892. In general terms, these difficulties consist in the silting up of Old River, the only navigable connection between the Mississippi and the Red and Atchafalaya rivers.

The works originally contemplated had in view the following objects:

To check the enlargement of the Atchafalaya and limit its outlet capacity by a system of low relief dams or sills.

To separate the Red from the Atchafalaya during low water and up to a 10-foot stage by means of a low dam at the west end of Turnbull Island, which would deflect the Red around the upper side of the island.

To supply a new outlet for the Red by cutting a canal across Carrs Point and obstructing the lower end of Upper Old River.

The Red would thus always be a tributary of the Mississippi at low stages and the Atchafalaya an outlet, while the conditions at high stage would remain about the same as they were originally.

The plan also contemplated maintaining low-water navigation through Lower Old River, if practicable, by dredging or otherwise, pending the completion of the above system of works.

Owing to insufficient funds, work on all parts of this project, except the first and last, has been suspended for many years, and experience having demonstrated that the channel in Lower Old River can be kept open with the dredge at moderate expense, even after having been exposed to the effects of extreme high water, it is understood that the improvement of the channel of Upper Old River has been definitely abandoned, narrowing the project to preventing the undue enlargement of the Atchafalaya and the maintenance of a navigable channel through Lower Old River.

The usual annual examination was made around the sill dams in December. The high water of 1899 not having been an extreme one and the current at ordinary stages having been principally from the Mississippi into the Atchafalaya, the survey shows but little scouring around the dams this year, and on the contrary a considerable deposit of sand above, below, and between the dams, amounting, however, to much less than the deposit which had taken place before the flood of 1897.

As experience has shown that a single extraordinary high water like that of 1897 will remove all this deposit and continue the attack on the original bed of the river above and below the dams, it has been thought necessary to widen the foundation mats above and below each dam and lay the foundation mat for a new dam immediately above the existing upper dam. This work will be undertaken next season.

Owing to the low stage of the Mississippi during the season, rather more than the usual amount of dredging became necessary in Old River. It is estimated that 109,000 cubic yards of material were dredged and deposited in the stream alongside the cut made by the dredge. The dredge was kept in Old River from July 29 to November 28, when the river rose to such a height as to make dredging no longer necessary.

A new steel hull has been built for the dredge *Ram*, and the machinery is now being transferred to it.

In compliance with a resolution of the Mississippi River Commission, a survey is now being made from Simmsport to Red River Landing, repeating the cross sections sounded in 1894, with a view to detecting any tendency to undue enlargement of the channel of Lower Old River.

The amount expended from June 30, 1899, to June 30, 1900, is $28,424.86, distributed as follows:

Office expenses (main office)		$1,136.66
Other administrative expenses		708.20
Dredging Old River (hired labor):		
Materials	$1,304.34	
Wages	3,243.59	
Subsistence	1,218.41	
		5,766.34
Surveys		300.00
Repairs to plant		17,949.88
Care of plant		993.55
New plant		1,384.39
Miscellaneous		185.84
Total		28,424.86

Money statement.

IMPROVING ATCHAFALAYA AND RED RIVERS, LOUISIANA.

July 1, 1899, balance unexpended	$77,312.85
June 30, 1900, amount expended during fiscal year	28,424.86
July 1, 1900, balance unexpended	48,887.99
July 1, 1900, outstanding liabilities	1,488.84
July 1, 1900, balance available	47,399.15
Amount that can be profitably expended in fiscal year ending June 30, 1902. Submitted in compliance with requirments of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	50,000.00

NEW ORLEANS HARBOR.

The approved project for the improvement of New Orleans Harbor contemplates the protection of the banks in all of the caving bends by means of sloping submerged spur dikes, made mostly of brush and stone, resting upon wide foot mats and spaced at intervals varying from 400 to 1,600 feet as circumstances may require, with continuous mattress revetment covering the intervals where necessary. The ultimate cost is not estimated.

At the close of the last working season the work completed comprised about 400 feet of mattress protection at the head of Carrollton Bend; two spur dikes in the Greenville Bend; six spur dikes in the Gouldsboro Bend; in the Third District Reach sixteen spur dikes had been completed, a continuous revetment constructed between Spurs 1 and 2, and a mattress 150 by 200 feet placed contiguous to the foundation mattress of Spurs 2′, 3′, 3½′, 4′, and 4½′.

The funds available June 30, 1899, amounted to $135,515.63, but no work other than the making of necessary surveys and the construction of barges was undertaken during the year, as all of the plant of the district had to be used throughout the season at Kempe and Giles Bend.

A project for the expenditure of the available balance was submitted April 28, 1900, and the construction of six spurs between Algiers Point and Gouldsboro has been approved. Work will be begun as soon as the stage of the river permits.

The amount expended from June 30, 1899, to June 30, 1900, is $6,800.44, distributed as follows:

Office expenses (main office)	$0.81
Other administrative expenses	81.80
Construction (hired labor) materials	984.94
Surveys	521.45
Repairs to plant	396.65
New plant	4,795.47
Miscellaneous	19.32
Total	6,800.44

Money statement.

IMPROVING HARBOR AT NEW ORLEANS, LA.

July 1, 1899, balance unexpended	[1]$116,765.63
June 30, 1900, amount expended during fiscal year	6,800.44
July 1, 1900, balance unexpended	109,965.19
Amount that can be profitably expended in fiscal year ending June 30, 1902. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897.	300,000.00

The amount expended from June 30, 1899, to June 30, 1900, is $6,183.38, distributed as follows:

Office expenses (main office)	$126.13
Other administrative expenses	219.44
Construction (hired labor) materials	5,736.98
Repairs to plant	29.40
Care of plant	24.30
New plant	41.38
Miscellaneous	5.75
Total	6,183.38

Money statement.

IMPROVING MISSISSIPPI RIVER—ALLOTMENT FOR HARBOR AT NEW ORLEANS, LA.

July 1, 1899, balance unexpended	$18,750.00
June 30, 1900, amount expended during fiscal year	6,183.38
July 1, 1900, balance unexpended	12,566.62
July 1, 1900, outstanding liabilities	133.04
July 1, 1900, balance available	12,433.58

REVETMENT IN BONDURANT CHUTE.

An allotment of $10,000 was made by the Mississippi River Commission June 21, 1899, for constructing a revetment 1,600 feet long in Bondurant Chute, to prevent for three years the breaching of the levee on the bank of the chute in front of Lake Bruin. It was intended to build this revetment during the fall, when sufficient plant could be spared from the more urgent work at Kempe Bend. Before this could be done, however, the river had fallen to a low stage, and the mouth of the chute was

[1] Balance unexpended July 1, 1899, as stated in previous report, $135,515.63. In this amount was included $18,750, which was allotted from the appropriation for improving Mississippi River for harbor at New Orleans, La. A separate financial statement for harbor at New Orleans, La., is submitted.

found to have shoaled so much since the previous year that it was not practicable to reach the site of the work with barges.

On March 19, 1900, the Mississippi River Commission made an additional allotment for this work and the revetment will be constructed early in the coming season.

As the river did not reach a high stage, there has been but little caving in Bondurant Chute this year. The maximum recession of the bank is reported as 25 feet.

Money statement.

IMPROVING BONDURANT CHUTE, LOUISIANA.

June 21, 1899, amount allotted from appropriation, sundry civil act of March 3, 1899	$10,000.00
March 19, 1900, amount allotted by resolution Mississippi River Commission from unallotted balance of sundry civil appropriation of March 3, 1899	10,000.00
July 1, 1900, balance unexpended	20,000.00

KEMPE BEND REVETMENT.

An allotment of $180,000 for Kempe Bend revetment was made by the Mississippi River Commission March 9, 1899; approved by the Secretary of War March 13, 1899.

This allotment was rendered necessary by the continued caving of the bank in Kempe Bend, threatening to destroy the levee which crosses the Kempe Swamp a few miles below St. Joseph, La. This swamp is very large, unusually low, and covered with a dense growth of timber, so that it is estimated that a properly located new levee across or around it would cost not less than half a million dollars.

A project for the expenditure of this allotment was approved by the Chief of Engineers May 19, 1899. It contemplates a continuous revetment about 6,000 feet long protecting that portion of the bank which is nearest to the levee. This length of revetment will be sufficient to protect the length of levee which is immediately threatened, but an additional allotment will be necessary to prolong the revetment both up and down stream during the coming season. The final cost of the work has not been estimated, as it is not known how far the revetment will ultimately have to be extended.

Work was begun in Kempe Bend September 21 and continued until February 23, 1900, when the high stage of the river caused a suspension of operations. At that date 4,008 linear feet of bank had been revetted.

The difficulties encountered in placing this revetment were exceptional on account of the great velocity of the current. Three steamboats had to be used to put the mattresses in place, work which is ordinarily done with a single boat. The revetment has been under severe strain, and the river has scoured away its bed as much as 20 feet in places beyond the edge of the mattress. A survey is now being made to show the extent of this scour. A recent inspection shows the bank pavement intact and the revetment in apparent good order.

Much difficulty has been experienced in this district in getting a reliable and economical supply of ballast for sinking mats. The contract price of rock has varied from $1.60 to $2.10 per ton, but deliveries have been so uncertain that it has been necessary in the general case to make rock contracts a year in advance and store the rock on the bank somewhere near the work in order that it may be available when needed. When to the contract price is added the cost of towing the rock to the storage ground, the cost of unloading it and piling it on the bank, the cost of again loading it on the barge and towing it to the point where it is neeeded, it is probable that the rock delivered at the work ready for use is not less than $2.50 per ton. It is difficult to tell the exact cost, because it is not practicable to compute accurately the cost of towing when the towboats are not employed steadily but are used also for other work.

To meet this difficulty experiments were made this season in making an exceedingly cheap grade of concrete, using the least possible amount of Portland cement to consolidate sufficiently well for the purpose the sand and gravel which lie mixed together on some of the river bars in the district.

About 10,311 tons of this ballast were made during the year at a cost of $1.63 per ton on the bar. The experiment was not entirely satisfactory, however, on account

of the excessive cost of subsequently loading the ballast aboard the barge, which amounted to $0.55 per ton. It is believed that improvements in methods and appliances will be made during the coming season which will meet the difficulties developed last year. Mr. A. F. Woolley, assistant engineer, superintended the making of the concrete ballast, and his report herewith describes in detail the methods used and the results obtained.

The economy to be expected from the use of concrete is not limited to the advantage in the first cost of the material as compared with rock, but is more apparent in the fact that a much less quantity can be made to serve the purpose, particularly in paving the upper bank.

Several types of upper bank pavement were experimented with on a large scale this year, and some of them give promise of great economy and efficiency as compared with the usual rock pavement.

The details of the work at Kempe Bend are fully set forth in the accompanying report of Mr. H. S. Douglas, assistant engineer.

The amount expended from June 30, 1899, to June 30, 1900, is $162,783.47, distributed as follows:

Office expenses (main office)		$5,350.03
Other administrative expenses		6,759.91
Construction of revetment (hired labor):		
Materials	$45,677.73	
Wages	66,080.06	
Subsistence	26,531.69	
		138,289.48
Surveys		1,725.73
Repairs to plant		1,721.37
Care of plant		2,383.72
New plant		5,927.30
Miscellaneous		625.93
Total		162,783.47

Money statement.

IMPROVING KEMPE BEND, LA.

March 9, 1899, amount allotted from appropriation, sundry civil act of March 3, 1899	$180,000.00
June, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900	150,000.00
	330,000.00
June 30, 1900, amount expended during fiscal year	162,783.47
July 1, 1900, balance unexpended	167,216.53
July 1, 1900, outstanding liabilities	$71.40
July 1, 1900, amount covered by uncompleted contracts	5,975.00
	6,046.40
July 1, 1900, balance available	161,170.13

DREDGING BARS BELOW NATCHEZ.

The bars in the Mississippi River at Natchez Island, Fords, Torras, and Tunica caused no serious difficulty to navigation during low water this season. No dredging was necessary, and none was done.

PLANT.

All of the plant of the district is in good condition, and is now undergoing the usual annual repairs preparatory to next season's work.

Two new barges, paid for by the Quartermaster's Department of the United States Army, were received during the year to take the place of barges 16 and 28, which were transferred during the Spanish war. Six others are now building, and will be

delivered in a few weeks, and bids for the construction of four more were opened May 26. The new steel towboat *Gen. John Newton*, built to replace the *Osceola*, was delivered and accepted early in the year, and a new steel tugboat was purchased, and has been named the *Gen. A. A. Humphreys*.

The plant of the Fourth district has always been comparatively small, having been constructed and maintained from the appropriations made from time to time for the two harbors in the district and the Red and Atchafalaya rivers. It has, however, now become necessary to so increase the plant that extensive revetment work may be carried on at two different localities at the same time, as there are five such pieces of work to be done in the district at present.

Further details as to the care and maintenance of the plant will be found in the report of Mr. H. S. Douglas, assistant engineer, herewith.

The amount expended from June 30, 1899, to June 30, 1900, is $61,702.10, distributed as follows:

Office expenses (main office)		$1,075.27
Other administrative expenses		2,494.19
New plant		38,407.90
Repairs (hired labor):		
Materials	$11,016.53	
Wages	6,001.22	
Subsistence	480.24	
		17,497.99
Care of plant		2,152.07
Miscellaneous		74.68
Total		61,702.10

Money statement.

PLANT.

July 1, 1899, balance unexpended		$78,112.73
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900		25,000.00
		103,112.73
June 30, 1900, amount expended during fiscal year		61,702.10
July 1, 1900, balance unexpended		41,410.63
July 1, 1900, outstanding liabilities	$6,541.07	
July 1, 1900, amount covered by uncompleted contracts	15,280.00	
		21,821.07
July 1, 1900, balance available		19,589.56

SURVEYS, GAUGES, AND OBSERVATIONS.

Surveys have been made at Algiers Point, Southport, Gouldsboro, the Third District Reach, Kempe Bend, Giles Bend, and from Simmesport to Red River Landing.

The gauge at Barbres Landing, at the junction of the Red and Atchafalaya rivers, has been maintained as heretofore.

The amount expended from June 30, 1899, to June 30, 1900, is $5,000, distributed as follows:

Office expenses (main office)		$193.22
Other administrative expenses		474.20
Field work and drafting:		
Materials	$196.97	
Wages	2,865.44	
Subsistence	987.47	
		4,049.88

Repairs to plant	$181.05
Care of plant	3.00
New plant	98.65
Total	5,000.00

Money statement.

SURVEYS, GAUGES, AND OBSERVATIONS.

July 1, 1899, balance unexpended	$5,000.00
June 27, 1900, amount allotted from appropriation sundry civil act of June 6, 1900	5,000.00
	10,000.00
June 30, 1900, amount expended during fiscal year	5,000.00
July 1, 1900, balance unexpended	5,000.00
July 1, 1900, outstanding liabilities	91.36
July 1, 1900, balance available	4,908.64

LEVEES.

For work connected with levee construction and maintenance the district is sub divided into seven levee districts, as follows:

The Lower Tensas Levee district, right bank, which extends from the upper limits of the Fourth district, opposite Warrenton, to the mouth of Red River. In this district the levee system is continuous from the upper end to a point 5 miles below Fairview Landing, 131.5 miles by river, leaving about 26 miles unprotected.

The Atchafalaya Levee district, right bank, which extends from the mouth of Red River to the head of Bayou Lafourche, a distance of 122 miles by river. The levee system is continuous in this district.

The Lafourche Levee district, right bank, extends from the head of Bayou Lafourche to New Orleans. The distance by river is 78 miles and the levee system is continuous.

The Barataria Levee district, right bank, which extends from New Orleans to the Head of the Passes, 82½ miles. The levee system is continuous down to the Jump, 71.5 miles.

The Homochitto Levee district, left bank, created by a resolution of the Mississippi River Commission, November 19, 1894, which extends from the mouth of the Yazoo River to Baton Rouge, 238.5 miles by river. There are as yet no levees in this district except a few detached lengths built by private parties.

The Pontchartrain Levee district, left bank, which extends from Baton Rouge to New Orleans, 123.5 miles. The levees are continuous.

The Lake Borgne Levee district, left bank, which extends from New Orleans to the Head of the Passes, 91 miles. The levee system at present only extends to Fort St. Philip, covering 70 miles of the river.

The funds available for levee construction in this district June 30, 1899, amounted to $803,697.95.

The construction and maintenance of an effective levee system is an undertaking of such vast magnitude that it is only financially practicable on condition of great economy in the expenditure of the available funds. The following table shows how the cost of levee building has varied in this district during recent years:

Year.	Cubic yardage.	Cost per cubic yard.
		Cents.
1890	895,000	19.3
1891	1,410,000	21.2
1892	908,000	17.8
1893	2,142,000	21.2
1894	3,589,000	15.0
1895	3,414,000	12.3
1896	4,658,000	10.3
1897	1,775,000	10.99
1898	3,392,000	14.12
1899	2,465,000	13.6

The past year has been a favorable one for levee building, rainy weather and the presence of yellow fever along the river having interfered but little with the progress of the work. On the other hand prices have been high, partly on account of the increased height of the levees and partly on account of the general rise in the price of labor and materials which has taken place throughout the country.

Efforts toward the introduction of machinery for levee building have been continued during the year, two such machines being now at work under contract; fair progress has been made, but the work can hardly be said to have gotten beyond the experimental stage as yet.

The highest gauge reading reached by the river this year was 38 feet at Vicksburg; no high-water protection work has been necessary, so that it has been possible to save and apply to the permanent improvement of the levee line all of the funds reserved for high-water emergencies.

The following table shows approximately the condition of the levee line on the completion of this year's contracts:

Levee districts.

	Lower Tensas.	Atchafalaya.	Lafourche.	Pontchartrain.	Barataria.	Lake Borgne.
Above high water of 1897—	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*	*Miles.*
Less than 1 foot	22.54	1.46	0.08	37.54	10.95	22.17
From 1 to 2 feet	13.47	12.31	6.98	35.68	33.54	13.11
From 2 to 3 feet	18.96	15.45	21.65	16.45	12.78	18.07
More than 3 feet	74.92	99.15	53.31	36.00	14.51	18.31
Total	129.89	128.37	82.02	125.67	71.78	71.66

The banquets called for by the standard cross section have as yet only been constructed in a few of the most urgent cases.

No work has been done in the Homochitto Levee district, there having been no funds available.

The details of the work accomplished during the year in the other districts are given in the following tables:

Fourth district levees, 1899–1900.

LOWER TENSAS LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Evergreen-Bondurant:						*Feet.*
1	Section 1	638	R.	Israel R. Bobbitt	519	380	3.0
2	Section 2	638	R.	do	500	422	3.0
3	Section 3	638	R.	do	500	390	3.0
4	Section 4	638	R.	do	500	415	3.0
5	Section 5	638	R.	do	400	320	3.0
6	Section 6	638	R.	do	400	335	3.0
7	Section 7	638	R.	do	400	325	3.0
8	Section 8	638	R.	do	400	341	3.0

Fourth district levees, 1899–1900—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Evergreen Bondurant:						Feet.
9	Section 9	638	R.	Israel R. Bobbitt	400	309	3.0
10	Section 10	638	R.	do	400	329	3.0
11	Section 11	639	R.	do	400	341	3.0
12	Section 12	639	R.	do	400	302	3.0
13	Section 13	639	R.	Lucian Bland	500	411	3.0
14	Section 14	639	R.	do	600	453	3.0
15	Section 15	639	R.	do	500	418	3.0
16	Section 16	639	R.	do	600	514	3.0
17	Section 17	639	R.	do	500	424	3.0
18	Section 18	639	R.	do	600	455	3.0
19	Section 19	639	R.	Israel R. Bobbitt	500	442	3.0
20	Section 20	639	R.	do	500	438	3.0
21	Section 21	639	R.	do	500	350	3.0
22	Section 22	639	R.	do	500	317	3.0
23	Section 23	639	R.	do	500	348	3.0
24	Section 24	639	R.	do	400	270	3.0
25	Section 25	639	R.	do	400	313	3.0
26	Section 26	639	R.	do	500	271	3.0
27	Section 27	639	R.	do	400	338	3.0
28	Section 28	639	R.	do	500	.....	3.0
29	Section 29	639	R.	do	600	.....	3.0
30	Section 30	639	R.	do	500	.....	5.0
31	Section 31	639	R.	Helgason Brothers	400	72	5.0
32	Section 32	639	R.	do	400	216	5.0
33	Section 33	639	R.	do	300	145	5.0
34	Section 34	639	R.	do	400	275	5.1
35	Section 35	639	R.	do	300	268	5.1
36	Section 36	639	R.	do	300	250	5.1
37	Section 37	639	R.	Batt O'Brien	300	286	5.1
38	Section 38	639	R.	do	300	283	5.2
39	Section 39	639	R.	do	300	288	5.2
40	Section 40	639	R.	do	300	321	5.2
41	Section 41	641	R.	do	300	278	5.2
42	Section 42	641	R.	do	200	185	5.3
43	Section 43	641	R.	Herman F. Garbish	300	324	5.3
44	Section 44	641	R.	do	300	286	5.3
45	Section 45	641	R.	do	300	280	5.3
46	Section 46	641	R.	do	400	311	5.4
47	Section 47	641	R.	do	500	190	5.4
48	Section 48	641	R.	do	600	198	5.4
49	Section 49	641	R.	H. J. Loonam	500	210	3.
50	Section 50	641	R.	do	500	195	3.
51	Section 51	641	R.	do	600	360	3.
52	Section 52	641	R.	do	500	275	3.
53	Section 53	641	R.	do	400	271	3.1
54	Section 54	641	R.	do	400	289	3.1
55	Section 55	642	R.	Clark & Reagan	700	485	3.1
56	Section 56	642	R.	do	800	516	3.1
57	Section 57	642	R.	do	700	548	3.2
58	Section 58	642	R.	do	800	665	3.2
59	Section 59	642	R.	do	800	735	3.2
60	Section 60	642	R.	do	700	640	3.2
61	Section 61	642	R.	Helgason Bros.	500	528	3.2
62	Catfish Bayou Dike	642	R.	do	200	199	3.2
	Evergreen-Bondurant:						
63	Section 63	642	R.	do	400	350	3.2
64	Section 64	642	R.	do	500	398	3.2
65	Section 65	642	R.	do	600	528	3.2
66	Section 66	642	R.	do	600	540	3.2
67	Section 67	643	R.	do	700	619	3.2
68	Section 68	643	R.	James R. Marlow	1,000	870	3.2
69	Section 69	643	R.	do	1,200	1,086	3.2
70	Section 70	643	R.	do	800	805	3.2
71	Section 71	643	R.	do	700	658	3.2
72	Section 72	643	R.	do	700	657	3.2
73	Section 73	643	R.	do	1,143	833	3.2
	Minnehaha:						
74	Section 1	650	R.	Theo. A. Helgason	600	595	2.3
75	Section 2	650	R.	do	600	580	2.6
76	Section 3	650	R.	do	600	568	2.9
77	Section 4	650	R.	do	682	624	3.2
	Aquasco:						
78	Section 1	679	R.	James R. Marlow	1,597	1,500	5.4
79	Section 2	679	R.	do	1,700	1,700	5.4
80	Section 3	679	R.	do	2,230	2,200	5.4

Fourth district levees, 1899–1900—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Esperanza:						*Feet.*
81	Section 18	711	R.	Helgason Bros	1,200	5,518	6
82	Section 19	711	R.	do	1,400	7,184	6
	Ashley:						
83	Section 1	724	R.	Jno. Scott & Sons	995	900	3
84	Section 4	724	R.	do	1,400	1,400	3
85	Section 5	724	R.	do	1,200	1,200	3
86	Section 6	724	R.	do	1,100	1,000	3
87	Section 7	724	R.	do	770	700	3
88	Section 8	724	R.	do	600	600	3
89	Section 9	724	R.	do	600	600	3
90	Section 10	724	R.	do	900	900	3
91	Section 11	724	R	do	1,000	400	3
	Glasscock, lot 3:						
92	Section 1	725	R.	Loonam & St. John	1,100	1,038	3
93	Section 2	725	R.	do	1,000	911	3
	Ashley-Fairview:						
94	Section 5	725	R.	D. P. Lyles	2,800	2,500	3

Fourth district levees, 1899–1900.

LOWER TENSAS LEVEE DISTRICT.

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Evergreen-Bondurant:	*Ft.*				*Feet.*	*Feet.*		
1	Section 1	8	3 to 1	3 to 1	New		13	July 18, 1899	Feb. 22, 1900
2	Section 2	8	3 to 1	3 to 1	do		13	do	Do.
3	Section 3	8	3 to 1	3 to 1	do		13.4	do	Do.
4	Section 4	8	3 to 1	3 to 1	do		13.4	do	Do.
5	Section 5	8	3 to 1	3 to 1	do		13.6	do	Do.
6	Section 6	8	3 to 1	3 to 1	do		13.6	do	Do.
7	Section 7	8	3 to 1	3 to 1	do		14	do	Mar. 3, 1900
8	Section 8	8	3 to 1	3 to 1	do		14	do	Do.
9	Section 9	8	3 to 1	3 to 1	do		13.8	do	Do.
10	Section 10	8	3 to 1	3 to 1	do		13.5	do	Do.
11	Section 11	8	3 to 1	3 to 1	do		13.5	do	Do.
12	Section 12	8	3 to 1	3 to 1	do		13.5	do	Do.
13	Section 13	8	3 to 1	3 to 1	do		13.4	do	Mar. 19, 1900
14	Section 14	8	3 to 1	3 to 1	do		13.3	do	Feb. 17, 1900
15	Section 15	8	3 to 1	3 to 1	do		13.3	do	Do.
16	Section 16	8	3 to 1	3 to 1	do		13.3	do	Nov. 18, 1899
17	Section 17	8	3 to 1	3 to 1	do		13.3	do	Oct. 4, 1899
18	Section 18	8	3 to 1	3 to 1	do		13.3	do	Sept. 21, 1899
19	Section 19	8	3 to 1	3 to 1	do		13.4	do	Sept. 12, 1899
20	Section 20	8	3 to 1	3 to 1	do		13.8	do	Aug. 30, 1899
21	Section 21	8	3 to 1	3 to 1	do		14	do	Oct. 12, 1899
22	Section 22	8	3 to 1	3 to 1	do		14.4	do	Nov. 2, 1899
23	Section 23	8	3 to 1	3 to 1	do		15	do	Nov. 23, 1899
24	Section 24	8	3 to 1	3 to 1	do		15.1	do	Oct. 6, 1899.
25	Section 25	8	3 to 1	3 to 1	do		15.2	do	Oct. 12, 1899
26	Section 26	8	3 to 1	3 to 1	do		15.4	do	Nov. 23, 1899
27	Section 27	8	3 to 1	3 to 1	do		15.6	do	Do.
28	Section 28	8	3 to 1	3 to 1	do		15.8	do	Oct. 18, 1899
29	Section 29	8	3 to 1	3 to 1	do		15.7	do	Oct. 6, 1899
30	Section 30	8	3 to 1	3 to 1	do		13.1	do	Aug. 30, 1899
31	Section 31	8	3 to 1	3 to 1	do		14.5	July 25, 1899	Nov. 17, 1899
32	Section 32	8	3 to 1	3 to 1	do		15.6	do	Do.
33	Section 33	8	3 to 1	3 to 1	do		15.9	do	Do.
34	Section 34	8	3 to 1	3 to 1	do		16	do	Do.
35	Section 35	8	3 to 1	3 to 1	do		16.1	do	Do.
36	Section 36	8	3 to 1	3 to 1	do		17.2	do	Do.

Fourth district levees, 1899–1900—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Evergreen-Bondurant—Continued.	Ft.				Feet.	Feet.		
37	Section 37	8	3 to 1	3 to 1	New		17.5	July 26, 1899	Jan. 16, 1900
38	Section 38	8	3 to 1	3 to 1	do		18.1	do	Do.
39	Section 39	8	3 to 1	3 to 1	do		18.3	do	Do.
40	Section 40	8	3 to 1	3 to 1	do		17.8	do	Do.
41	Section 41	8	3 to 1	3 to 1	do		17.6	do	Do.
42	Section 42	8	3 to 1	3 to 1	do		17.7	do	Do.
43	Section 43	8	3 to 1	3 to 1	do		17.5	July 13, 1899	Jan. 26, 1900
44	Section 44	8	3 to 1	3 to 1	do		17.2	do	Do.
45	Section 45	8	3 to 1	3 to 1	do		17.1	do	Do.
46	Section 46	8	3 to 1	3 to 1	do		15.7	do	Do.
47	Section 47	8	3 to 1	3 to 1	do		14.2	do	Do.
48	Section 48	8	3 to 1	3 to 1	do		14.2	do	Do.
49	Section 49	8	3 to 1	3 to 1	do		14.1	do	Sept. 20, 1899
50	Section 50	8	3 to 1	3 to 1	do		12	do	Oct. 5, 1899
51	Section 51	8	3 to 1	3 to 1	do		13	do	Oct. 15, 1899
52	Section 52	8	3 to 1	3 to 1	do		13.5	do	Nov. 9, 1899
53	Section 53	8	3 to 1	3 to 1	do		14.7	do	Jan. 22, 1900
54	Section 54	8	3 to 1	3 to 1	do		14.5	do	Do.
55	Section 55	8	3 to 1	3 to 1	do		11.5	do	Nov. 18, 1899
56	Section 56	8	3 to 1	3 to 1	do		10.3	do	Nov. 7, 1899
57	Section 57	8	3 to 1	3 to 1	do		10.8	do	Nov. 1, 1899
58	Section 58	8	3 to 1	3 to 1	do		10.8	do	Oct. 12, 1899
59	Section 59	8	3 to 1	3 to 1	do		10.6	do	Do.
60	Section 60	8	3 to 1	3 to 1	do		10.6	do	Sept. 4, 1899
61	Section 61	8	3 to 1	3 to 1	do		11.9	July 12, 1899	Nov. 12, 1899
62	Catfish Bayou Dike	8	3 to 1	3 to 1	do		20.2	Sept. 29, 1899	Oct. 31, 1899
	Evergreen-Bondurant:								
63	Section 63	8	3 to 1	3 to 1	do		14.8	July 12, 1899	Nov. 12, 1899
64	Section 64	8	3 to 1	3 to 1	do		12.3	do	Aug. 31, 1899
65	Section 65	8	3 to 1	3 to 1	do		10.9	do	Aug. 30, 1899
66	Section 66	8	3 to 1	3 to 1	do		11	do	Oct. 10, 1899
67	Section 67	8	3 to 1	3 to 1	do		10.7	do	Do.
68	Section 68	8	3 to 1	3 to 1	do		10.6	do	Oct. 31, 1899
69	Section 69	8	3 to 1	3 to 1	do		10.5	do	Oct. 2, 1899
70	Section 70	8	3 to 1	3 to 1	do		11.9	do	Sept. 9, 1899
71	Section 71	8	3 to 1	3 to 1	do		12.6	do	Jan. 7, 1900
72	Section 72	8	3 to 1	3 to 1	do		12.8	do	Nov. 8, 1899
73	Section 73	8	3 to 1	3 to 1	do		10.1	do	Sept. 30, 1899
	Minnehaha:								
74	Section 1	8	3 to 1	3 to 1	do		12.9	Sept. 29, 1899	Jan. 24, 1899
75	Section 2	8	3 to 1	3 to 1	do		13.2	do	Do.
76	Section 3	8	3 to 1	3 to 1	do		12	do	Jan. 25, 1900
77	Section 4	8	3 to 1	3 to 1	do		11.4	do	Feb. 13, 1900
	Aquasco:								
78	Section 1	8	3 to 1	3 to 1	Enlargement.	2	14.6	Apr. 18, 1899	July 29, 1899
79	Section 2	8	3 to 1	3 to 1	do	2.3	14.7	do	Jan. 22, 1900
80	Section 3	8	3 to 1	3 to 1	do	1.9	13.5	do	July 20, 1899
	Esperanza:								
81	Section 18	8	3 to 1	3 to 1	do	3.7	16.9	Oct. 31, 1899	Feb. 23, 1900
82	Section 19	8	3 to 1	3 to 1	do	3.9	15.5	do	Feb. 21, 1900
	Ashley:								
83	Section 1	8	3 to 1	3 to 1	New		11.6	Oct. 8, 1898	July 20, 1899
84	Section 4	8	3 to 1	3 to 1	do		9.4	do	May 20, 1899
85	Section 5	8	3 to 1	3 to 1	do		10.3	do	Mar. 1, 1899
86	Section 6	8	3 to 1	3 to 1	do		10.8	do	Feb. 23, 1899
87	Section 7	8	3 to 1	3 to 1	do		11.1	do	May 20, 1899
88	Section 8	8	3 to 1	3 to 1	do		12.7	do	July 20, 1899
89	Section 9	8	3 to 1	3 to 1	do		14	do	Do.
90	Section 10	8	3 to 1	3 to 1	do		13.1	do	Do.
91	Section 11	8	3 to 1	3 to 1	do		11.8	do	May 20, 1899
	Glasscock, lot 3:								
92	Section 1	8	3 to 1	3 to 1	Enlargement.	1.8	11.5	Nov. 28, 1899	Mar. 8, 1900
93	Section 2	8	3 to 1	3 to 1	do	1.6	12.4	do	Mar. 22, 1900
	Ashley-Fairview:								
94	Section 5	8	3 to 1	3 to 1	do	2.3	14	Oct. 26, 1896	Feb. 20, 1900

Fourth district levees, 1899–1900—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Evergreen Bondurant:	*Cubic yards.*	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	12,978.16	16.20	$2,101.68	3,165	3,345	3,245	Caving.
2	Section 2	13,294.85	16.20	2,153.76	3,345	3,538	3,451	Do.
3	Section 3	14,149.01	16.20	2,292.14	3,538	3,730	3,624	Do.
4	Section 4	14,302.52	16.20	2,317.01	3,730	3,950	3,830	Do.
5	Section 5	11,353.77	16.20	1,839.31	3,950	4,030	5,880	Do.
6	Section 6	11,939.58	16.20	1,934.21	4,060	4,165	4,087	Do.
7	Section 7	11,489.81	16.70	1,918.80	4,165	4,211	4,183	Do.
8	Section 8	11,903.58	16.70	1,987.90	4,211	4,334	4,377	Do.
9	Section 9	11,502.41	16.70	1,920.90	4,334	4,500	4,412	Do.
10	Section 10	10,901.72	16.70	1,820.59	4,500	4,645	4,577	Do.
11	Section 11	10,777.57	16.70	1,799.85	4,645	4,735	4,685	Do.
12	Section 12	10,440.06	16.70	1,743.49	4,735	4,768	4,746	Do.
13	Section 13	13,064.90	15.19	1,984.56	4,768	4,815	4,796	Do.
14	Section 14	14,389.63	15.19	2,185.78	4,815	4,951	4,878	Do.
15	Section 15	11,786.09	15.19	1,790.31	4,951	4,958	4,959	Do.
16	Section 16	14,066.72	15.19	2,136.72	4,958	5,019	4,983	Do.
17	Section 17	11,513.67	15.19	1,748.93	5,019	5,023	5,025	Do.
18	Section 18	13,099.31	15.19	1,989.78	5,023	5,100	5,095	Do.
19	Section 19	11,655.96	16.50	1,923.23	5,081	5,219	5,145	Do.
20	Section 20	12,364.82	16.50	2,040.20	5,081	5,100	5,095	Do.
21	Section 21	12,942.70	16.50	2,135.55	5,219	5,428	5,328	Do.
22	Section 22	14,469.60	16.50	2,387.48	5,428	5,700	5,559	Do.
23	Section 23	14,539.68	16.50	2,399.05	5,700	5,980	5,845	Do.
24	Section 24	11,862.76	16.50	1,957.36	5,980	6,250	6,110	Do.
25	Section 25	11,550.42	16.50	1,905.82	6,250	6,565	6,412	Do.
26	Section 26	14,635.55	16.50	2,414.87	6,565	6,849	6,702	Do.
27	Section 27	12,483.70	16.50	2,059.81	6,849	7,135	6,987	Do.
28	Section 28	15,752.27	16.50	2,599.13	7,135	7,550	7,347	Do.
29	Section 29	14,066.64	16.50	2,320.98	7,550	8,110	7,825	Do.
30	Section 30	13,231.70	16.50	2,183.23	8,110	8,505	8,302	Do.
31	Section 31	11,156.85	20.00	2,231.37	8,505	8,800	8,657	Do.
32	Section 32	12,441.38	20.00	2,488.28	8,800	9,170	8,980	Do.
33	Section 33	10,417.88	20.00	2,083.58	9,170	9,400	9,290	Do.
34	Section 34	13,520.00	20.00	2,704.00	9,400	9,650	9,520	Do.
35	Section 35	10,321.42	20.00	2,064.28	9,650	9,715	9,687	Do.
36	Section 36	11,808.66	20.00	2,361.73	9,715	9,805	9,755	Do.
37	Section 37	12,478.84	22.00	2,745.34	9,805	9,885	9,850	Do.
38	Section 38	13,359.83	22.00	2,939.16	9,885	9,900	9,897	Do.
39	Section 39	12,390.00	22.00	2,844.60	9,900	9,981	9,935	Do.
40	Section 40	12,181.89	22.00	2,680.02	10,040	10,100	10,065	Do.
41	Section 41	13,113.59	22.00	2,884.99	10,040	10,100	10,065	Do.
42	Section 42	9,120.74	22.00	2,006.56	10,100	10,120	10,105	Do.
43	Section 43	12,293.56	24.75	3,042.66	10,120	10,320	10,225	Do.
44	Section 44	12,437.60	24.75	3,078.31	10,320	10,365	10,337	Do.
45	Section 45	12,463.06	24.75	3,084.61	10,328	10,365	10,341	Do.
46	Section 46	13,283.24	24.75	3,287.60	10,250	10,328	10,284	Do.
47	Section 47	13,415.13	24.75	3,320.24	9,880	10,250	10,070	Do.
48	Section 48	14,570.87	24.75	3,606.29	9,475	9,880	9,672	Do.
49	Section 49	13,214.57	14.50	1,916.11	8,950	9,475	9,217	Do.
50	Section 50	11,083.90	14.50	1,607.16	8,570	8,950	8,755	Do.
51	Section 51	12,538.27	14.50	1,818.05	8,100	8,570	6,840	Do.
52	Section 52	13,003.16	14.50	1,885.46	7,745	8,100	7,927	Do.
53	Section 53	11,507.06	14.50	1,668.52	7,315	7,745	7,530	Do.
54	Section 54	12,989.08	14.50	1,883.41	7,165	7,315	7,245	Do.
55	Section 55	11,548.22	13.00	1,501.27	6,800	7,165	6,987	Do.
56	Section 56	11,274.81	13.00	1,465.73	6,284	6,800	6,537	Do.
57	Section 57	11,345.11	13.00	1,474.86	6,023	6,284	6,158	Do.
58	Section 58	12,432.70	13.00	1,616.25	5,860	6,022	5,946	Do.
59	Section 59	12,051.85	13.00	1,566.74	5,860	5,860	5,782	Do.
60	Section 60	12,515.52	13.00	1,627.02	5,715	5,800	5,752	Do.
61	Section 61	9,821.13	14.95	1,468.26	5,770	5,800	5,790	Do.
62	Catfish Bayou Dike.	14,825.32	17.50	2,594.43	5,770	5,880	5,820	Do.
	Evergreen-Bondurant:							
63	Section 63	11,807.99	14.95	1,765.80	5,880	6,005	5,937	Do.
64	Section 64	11,031.24	14.95	1,649.17	6,005	6,200	6,107	Do.
65	Section 65	10,366.16	14.95	1,549.74	6,000	6,200	6,105	Do.
66	Section 66	10,319.61	14.95	1,542.78	5,240	6,000	5,625	Do.
67	Section 67	11,329.21	14.95	1,693.72	4,350	5,240	4,781	Do.
68	Section 68	15,310.92	12.90	1,975.11	3,160	4,350	3,764	Do.
69	Section 69	16,546.18	12.90	2,134.46	2,335	3,160	2,741	Do.
70	Section 70	15,552.76	12.90	2,006.31	2,100	2,335	2,221	Do.
71	Section 71	14,968.48	12.90	1,930.94	1,590	2,100	1,849	Do.
72	Section 72	14,926.69	12.90	1,925.54	1,285	1,590	1,430	Do.
73	Section 73	15,033.60	12.90	1,939.33	635	1,285	969	Do.

Fourth district levees, 1899–1900—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Minnehaha:	*Cubic yards.*	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
74	Section 1	13,655.56	12.73	$1,738.35	3,843	4,000	3,976	Do.
75	Section 2	13,476.22	12.73	1,715.52	3,829	3,943	3,881	Do.
76	Section 3	13,771.74	12.73	1,753.14	3,748	3,829	3,798	Do.
77	Section 4	11,355.42	12.73	1,445.54	3,665	3,748	3,701	Do.
	Aquasco:							
78	Section 1	13,139.16	11.99	1,575.39	1,980	2,640	2,310	Do.
79	Section 2	13,549.17	11.99	1,624.54	1,980	1,980	1,980	Do.
80	Section 3	13,501.57	11.99	1,618.84	1,500	1,980	1,740	Do.
	Esperanza:							
81	Section 18	21,130.75	19.70	4,162.76	8,009	12,025	10,012	Do.
82	Section 19	19,588.61	19.70	3,858.95	8,451	12,025	10,242	Do.
	Ashley:							
83	Section 1	17,999.55	11.36	2,044.74	2,200	2,485	2,247	Do.
84	Section 4	20,005.56	11.36	2,272.64	3,230	3,870	3,545	Do.
85	Section 5	19,771.94	11.36	2,246.09	3,870	3,965	3,922	Do.
86	Section 6	19,100.89	11.36	2,169.86	3,965	4,225	4,090	Do.
87	Section 7	16,174.26	11.36	1,837.39	4,181	4,222	4,208	Do.
88	Section 8	16,499.02	11.36	1,874.29	3,985	4,181	4,066	Do.
89	Section 9	16,371.83	11.36	1,859.84	3,384	3,985	3,679	Do.
90	Section 10	17,884.32	11.36	2,031.66	2,455	3,384	2,914	Do.
91	Section 11	18,162.49	11.36	2,063.26	1,465	2,455	1,964	Do.
	Glasscock, lot 3:							
92	Section 1	12,438.23	20.00	2,487.65	1,670	1,890	1,785	Do.
93	Section 2	10,350.44	20.00	2,070.09	1,563	1,670	1,612	Do.
	Ashley-Fairview:							
94	Section 5	26,094.86	14.50	3,970.22	1,078	1,565	1,342	Do.

LOWER TENSAS LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Stockridge:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	659	R.	Clark & Reagan	1,629	1,000	3.0
2	Section 2	659	R.	.....do	1,400	800	3.0
3	Section 3	659	R.	.....do	1,400	1,400	3.0
4	Section 4	659	R.	.....do	1,300	1,300	3.0
	Esperanza:						
5	Section 1	711	R.	Batt O'Brien	800	700	5.8
6	Section 2	711	R.	.....do	1,000	900	5.8
7	Section 3	711	R.	.....do	800	700	5.8
8	Section 4	711	R.	.....do	800	700	5.8
9	Section 16	713	R.	Helgason Bros.	1,200	900	5.8
10	Section 17	713	R.	.....do	1,200	900	5.8
	Glasscock, lot 1:						
11	Sections 1-3	724	R.	Batt O'Brien	3,100	3,100	3.0
	Glasscock, lot 2:						
12	Sections 1-3	725	R.	.....do	2,574	2,574	3.0

Fourth district levees, 1899–1900—Continued.

LOWER TENSAS LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Total yardage.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Stockridge:	*Feet.*				*Feet.*	*Feet.*	1898.	*Cubic yds.*
1	Section 1	8	3 to 1	3 to 1	Enlargement.	3.0	12	July 28	15,139.47
2	Section 2	8	3 to 1	3 to 1	....do...	3.0	12.0	....do...	14,590.84
3	Section 3	8	3 to 1	3 to 1	....do...	3.0	18.0	....do...	15,635.40
4	Section 4	8	3 to 1	3 to 1	....do...	3.0	15.0	....do...	14,619.66
	Esperanza:								
5	Section 1	8	3 to 1	3 to 1	....do...	4.0	16.2	Oct. 8	14,599.98
6	Section 2	8	3 to 1	3 to 1	....do...	4.0	18.0	....do...	15,755.02
7	Section 3	8	3 to 1	3 to 1	....do...	4.0	17.3	....do...	14,810.06
8	Section 4	8	3 to 1	3 to 1	....do...	4.0	17.7	....do...	14,523.12
								1889.	
9	Section 16	8	3 to 1	3 to 1	....do...	4.0	16.0	Oct. 31	19,278.22
10	Section 17	8	3 to 1	3 to 1	....do...	4.0	15.0	....do...	18,348.08
								1900.	
	Glasscock, lot 1:								
11	Sections 1–3	8	3 to 1	3 to 1	....do...	2.5	14.0	Mar. 29	24,898.46
	Glasscock, lot 2:								
12	Sections 1–3	8	3 to 1	3 to 1	....do...	2.5	15.4	May 15	26,772.88

No.	Name of levee.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition of contract.
			Least.	Greatest.	Average.		
	Stockbridge:	*Cents.*	*Feet.*	*Feet.*	*Feet.*		
1	Section 1	13.00	6,000	5,000	5,500	Caving	100 per cent in place.
2	Section 2	13.00	5,000	4,600	4,800	.....do.....	87 per cent in place.
3	Section 3	13.00	1,700	1,700	1,700	.....do.....	Nothing done.
4	Section 4	13.00	2,100	2,100	*2,100	.....do.....	60 per cent in place.
	Esperanza:						
5	Section 1	19.90	2,600	2,600	2,600	Stationary..	Nothing done.
6	Section 2	19.90	3,000	3,000	3,000	.....do.....	Do.
7	Section 3	19.90	3,200	3,400	3,300	.....do.....	Do.
8	Section 4	19.90	1,640	1,795	1,710	Caving	6 per cent in place.
9	Section 16	19.70	4,000	3,000	3,500	Stationary..	99 per cent in place.
10	Section 17	19.70	3,000	2,700	2,850	.....do.....	24 per cent in place.
	Glasscock, lot 1:						
11	Sections 1–3	16.30	1,800	1,700	1,750	Caving	40 per cent in place.
	Glasscock, lot 2:						
12	Sections 1–3	16.30	2,000	1,800	1,900	.....do.....	Nothing done.

Fourth district levees, 1899–1900—Continued.

ATCHAFALAYA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
					Feet.	*Feet.*	*Feet.*
	Watson:						
1	Section 1	794	R.	N. P. Philips	710	630	5.9
2	Section 2	794	R.	do	300	240	5.9
3	Section 3	794	R.	do	300	290	5.9
4	Section 4	794	R.	do	392	380	5.9
	Buquoi:						
5	Section 1	794	R.	do	447	440	5.9
6	Section 2	794	R.	do	400	400	5.9
7	Section 3	794	R.	do	529	520	5.9
	Nina:						
8	Section 6	806	R.	F. M. McLaughlin	1,000	500	5.4
9	Section 8	806	R.	do	1,100	1,000	5.4
	Hermitage:						
10	Section 1	808	R.	W. F. Barbour & Son	700	570	5.7
11	Section 2	808	R.	do	700	330	5.7
12	Section 3	808	R.	do	927	780	4.7
	Barroza:						
13	Section 3	824	R.	Sam Robertson	800	750	4.3
14	Section 4	824	R.	do	1,000	970	4.3
15	Section 5	824	R.	do	900	880	4.3
16	Section 6	824	R.	do	760	760	4.3
17	Section 11	824	R.	Dilworth-Scudder Dredging Co.	237	230	4.2
18	Section 12	824	R.	do	1,000	1,000	4.2
19	Section 13	824	R.	do	900	900	4.2
20	Section 14	824	R.	do	735	730	4.2
	Homestead:						
21	Section 1	833	R.	Helgason Brothers	1,012	1,000	4.5
22	Section 2	833	R.	do	900	900	4.5
23	Section 3	833	R.	do	1,100	1,100	4.5
24	Section 4	833	R.	do	900	900	4.5
25	Section 5	833	R.	do	800	740	4.5
	Port Allen:						
26	Section 1	833	R.	do	578	575	4.5
27	Section 5	834	R.	do	763	760	4.6
	Beaulieu-Antonio:						
28	Section 1	836	R.	M. L. Linnan	1,600	1,600	3
29	Section 2	836	R.	do	1,400	1,300	3
30	Section 5	836	R.	do	1,400	1,500	3
	Cinclare:						
31	Section 1	837	R.	George Byrne	1,200	1,200	4.6
32	Section 2	837	R.	do	1,000	990	4.6
33	Section 3	837	R.	do	1,000	1,000	4.6
34	Section 4	837	R.	do	900	880	4.6
35	Section 5	837	R.	do	1,000	990	4.6
	Brusly:						
36	Section 1	838	R.	J. W. Whipple & Son	900	900	4.6
37	Section 2	838	R.	do	900	900	4.6
38	Section 3	838	R.	do	1,000	960	4.6
39	Section 4	838	R.	do	800	530	4.6
40	Section 5	838	R.	do	900	900	4.6
	Missouri:						
41	Section 2	840	R.	Israel R. Bobbitt	1,700	1,400	3
42	Section 3	840	R.	do	1,600	1,600	3
43	Section 4	840	R.	do	1,736	1,500	3
	St. Delphine:						
44	Section 1	841	R.	F. M. McLaughlin	691	400	4.6
45	Section 2	841	R.	do	700	530	4.6
46	Section 3	841	R.	do	600	440	4.6
47	Section 4	841	R.	do	664	500	4.6
	Australia:						
48	Section 1	846	R.	M. L. Linnan	1,870	2,900	3
49	Section 2	846	R.	do	1,962	2,900	3

Fourth district levees, 1899–1900—Continued.

ATCHAFALAYA LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Watson:	*Ft.*				*Feet.*	*Feet.*		
1	Section 1	8	3 to 1	3 to 1	New and enlargement.	2.2	20.9	Sept. 29, 1899	Mar. 15, 1900
2	Section 2	8	3 to 1	3 to 1	New	.....	14.6	.....do	Feb. 1, 1900
3	Section 3	8	3 to 1	3 to 1	....do	.....	16.8	.....do	Feb. 21, 1900
4	Section 4	8	3 to 1	3 to 1	....do	.....	14.3	.....do	Jan. 20, 1900
	Buquoi:								
5	Section 1	8	3 to 1	3 to 1	....do	.....	14.1	Oct. 5, 1899	Dec. 14, 1899
6	Section 2	8	3 to 1	3 to 1	....do	.....	14.1	.....do	Jan. 29, 1900
7	Section 3	8	3 to 1	3 to 1	....do	.....	14.1	.....do	Do.
	Nina:								
8	Section 6	8	3 to 1	3 to 1	Enlargement.	8	19.7	Jan. 5, 1898	July 31, 1899
9	Section 8	8	3 to 1	3 to 1	....do	8.2	18.4	.....do	Do.
	Hermitage:								
10	Section 1	8	3 to 1	3 to 1	....do	4.4	17.7	Dec. 1, 1899	Feb. 24, 1900
11	Section 2	8	3 to 1	3 to 1	....do	3.8	25	.....do	Jan. 6, 1900
12	Section 3	8	3 to 1	3 to 1	....do	3.4	20.6	.....do	Mar. 21, 1900
	Barroza:								
13	Section 3	8	3 to 1	3 to 1	....do	2.8	22.2	Oct. 5, 1899	Feb. 15, 1900
14	Section 4	8	3 to 1	3 to 1	....do	2.8	20	.....do	Jan. 4, 1900
15	Section 5	8	3 to 1	3 to 1	....do	2.8	21.4	.....do	Mar. 11, 1900
16	Section 6	8	3 to 1	3 to 1	....do	3	21.7	.....do	Apr. 5, 1900
17	Section 11	8	3 to 1	3 to 1	....do	2.3	20.1	June 1, 1898	July 5, 1899
18	Section 12	8	3 to 1	3 to 1	....do	3	20.4	.....do	Do.
19	Section 13	8	3 to 1	3 to 1	....do	3.2	21.2	.....do	Do.
20	Section 14	8	3 to 1	3 to 1	....do	2.6	21.8	.....do	Do.
	Homestead:								
21	Section 1	8	3 to 1	3 to 1	....do	2.2	15.2	Sept. 29, 1899	Feb. 23, 1900
22	Section 2	8	3 to 1	3 to 1	....do	2.3	16.9	.....do	Feb. 1, 1900
23	Section 3	8	3 to 1	3 to 1	....do	2.4	15.6	.....do	Jan. 5, 1900
24	Section 4	8	3 to 1	3 to 1	....do	2.6	17.5	.....do	Dec. 19, 1899
25	Section 5	8	3 to 1	3 to 1	....do	3.4	18.2	.....do	Feb. 26, 1900
	Port Allen:								
26	Section 1	8	3 to 1	3 to 1	....do	2.1	17.8	Jan. 30, 1900	Apr. 4, 1900
27	Section 5	8	3 to 1	3 to 1	....do	2.7	17.2	.....do	Apr. 13, 1900
	Beaulieu-Antonio:								
28	Section 1	8	3 to 1	3 to 1	....do	2.3	15.2	Oct. 1, 1898	Sept. 19, 1899
29	Section 2	8	3 to 1	3 to 1	....do	2.2	15.2	.....do	Do.
30	Section 5	8	3 to 1	3 to 1	....do	1.9	14.2	.....do	Do.
	Cinclare:								
31	Section 1	8	3 to 1	3 to 1	....do	3.4	14.1	Sept. 29, 1899	Jan. 20, 1900
32	Section 2	8	3 to 1	3 to 1	....do	4.2	13.5	.....do	Dec. 18, 1899
33	Section 3	8	3 to 1	3 to 1	....do	4.2	14.6	.....do	Dec. 15, 1899
34	Section 4	8	3 to 1	3 to 1	....do	3.9	15.1	.....do	Jan. 9, 1900
35	Section 5	8	3 to 1	3 to 1	....do	3.8	16.4	.....do	Nov. 17, 1899
	Brusly:								
36	Section 1	8	3 to 1	3 to 1	....do	3.7	16.4	.....do	Do.
37	Section 2	8	3 to 1	3 to 1	....do	4.2	16.5	.....do	Dec. 30, 1899
38	Section 3	8	3 to 1	3 to 1	....do	3.9	16.3	.....do	Feb. 26, 1900
39	Section 4	8	3 to 1	3 to 1	....do	4	17.1	.....do	Feb. 1, 1900
40	Section 5	8	3 to 1	3 to 1	....do	3.8	17.2	.....do	Dec. 7, 1899
	Missouri:								
41	Section 2	8	3 to 1	3 to 1	....do	2.2	15.2	Oct. 1, 1898	July 7, 1899
42	Section 3	8	3 to 1	3 to 1	....do	2.4	15.6	.....do	July 14, 1899
43	Section 4	8	3 to 1	3 to 1	....do	3.1	16.1	.....do	July 20, 1899
	St. Delphine:								
44	Section 1	8	3 to 1	3 to 1	....do	3.4	18.3	Sept. 29, 1899	Feb. 20, 1900
45	Section 2	8	3 to 1	3 to 1	....do	3.8	18.4	.....do	Jan. 25, 1900
46	Section 3	8	3 to 1	3 to 1	....do	3.8	20	.....do	Do.
47	Section 4	8	3 to 1	3 to 1	....do	3.8	19.3	.....do	Dec. 2, 1899
	Australia:								
48	Section 1	8	3 to 1	3 to 1	....do	2.2	12.7	Oct. 1, 1898	Aug. 12, 1899
49	Section 2	8	3 to 1	3 to 1	....do	2.4	12.4	.....do	Do.

Fourth district levees, 1899–1900—Continued.

ATCHAFALAYA LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Watson:		*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	11,399.10	13.25	$1,510.39	200	320	300	Making.
2	Section 2	10,147.90	13.25	1,344.60	310	320	315	Do.
3	Section 3	11,624.82	13.25	1,540.29	310	310	310	Do.
4	Section 4	10,150.30	13.25	1,344.92	220	310	260	Do.
	Buquoi:							
5	Section 1	10,807.24	12.00	1,296.87	290	290	290	Do.
6	Section 2	9,781.88	12.00	1,173.82	260	290	270	Do.
7	Section 3	11,612.60	12.00	1,393.51	210	260	240	Do.
	Nina:							
8	Section 6	16,810.89	16.25	2,731.77	680	1,000	750	Do.
9	Section 8	19,008.56	16.25	3,088.89	1,320	1,600	1,500	Caving.
	Hermitage:							
10	Section 1	12,965.14	19.00	2,463.38	2,400	2,450	2,425	Do.
11	Section 2	13,509.97	19.00	2,566.89	2,180	2,780	2,500	Do.
12	Section 3	12,748.78	19.00	2,422.27	2,180	2,300	2,200	Do.
	Barroza:							
13	Section 3	14,270.26	22.50	3,210.81	880	1,010	900	Do.
14	Section 4	15,505.47	22.50	3,488.73	840	890	870	Do.
15	Section 5	15,452.51	22.50	3,476.81	820	840	830	Do.
16	Section 6	13,736.19	22.50	3,090.64	650	840	800	Do.
17	Section 11	3,664.13	14.00	512.98	1,050	1,100	1,100	Do.
18	Section 12	15,371.74	14.00	2,152.04	760	1,100	1,000	Do.
19	Section 13	15,767.66	14.00	2,207.47	760	1,100	1,000	Do.
20	Section 14	10,936.76	14.00	1,531.15	840	1,100	1,000	Do.
	Homestead:							
21	Section 1	13,280.32	13.95	1,852.61	240	265	250	Do.
22	Section 2	13,761.87	13.95	1,919.78	240	280	260	Do.
23	Section 3	13,987.87	13.95	1,951.31	280	337	300	Do.
24	Section 4	12,953.94	13.95	1,807.07	240	295	270	Do.
25	Section 5	12,906.63	13.95	1,800.47	250	295	290	Do.
	Port Allen:							
26	Section 1	10,218.50	13.80	1,359.06	270	270	270	Do.
27	Section 5	12,833.26	14.20	1,822.32	190	250	220	Washing.
	Beaulieu-Antonio:							
28	Section 1	15,767.52	10.97	1,729.70	480	600	540	Making.
29	Section 2	15,457.84	10.97	1,696.73	500	540	530	Do.
30	Section 5	15,888.62	10.97	1,742.98	120	180	160	Do.
	Cinclare:							
31	Section 1	13,644.16	12.87	1,756.00	200	200	200	Do.
32	Section 2	12,499.15	12.87	1,608.54	200	210	200	Do.
33	Section 3	12,450.50	12.87	1,602.38	160	200	190	Do.
34	Section 4	12,097.26	12.87	1,556.92	200	320	260	Do.
35	Section 5	13,422.27	12.87	1,727.45	320	320	320	Do.
	Brusly:							
36	Section 1	13,665.59	14.00	1,913.18	280	330	300	Do.
37	Section 2	13,548.95	14.00	1,896.85	180	280	230	Stationary
38	Section 3	13,610.07	14.00	1,905.41	140	200	160	Do.
39	Section 4	13,152.87	14.00	1,841.40	200	325	300	Do.
40	Section 5	13,961.99	14.00	1,954.68	300	325	310	Washing.
	Missouri:							
41	Section 2	16,332.99	14.50	2,368.28	250	450	400	Caving.
42	Section 3	15,357.85	14.50	2,226.89	450	635	600	Do.
43	Section 4	15,868.88	14.50	2,300.99	200	640	600	Do.
	St. Delphine:							
44	Section 1	11,603.87	16.25	1,885.80	180	370	300	Do.
45	Section 2	12,017.21	16.25	1,952.80	370	430	400	Do.
46	Section 3	11,740.49	16.25	1,907.83	430	540	490	Do.
47	Section 4	12,858.31	16.25	2,089.48	540	570	560	Do.
	Australia:							
48	Section 1	13,549.95	10.97	1,486.43	160	560	380	Washing.
49	Section 2	12,798.17	10.97	1,403.41	220	560	400	Do.

Fourth district levees, 1899–1900—Continued.

ATCHAFALAYA LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Grand Bay:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	808	R.	Whipple & Scott	596	550	5.7
2	Section 2	808	R.	do	500	465	5.7
3	Section 3	808	R.	do	500	465	5.7
	Devall:						
4	Section 1	823	R.	Ernest Hyner	1,024	400	4.4
5	Section 2	823	R.	do	800	730	4.4
6	Section 3	823	R.	do	900	820	4.4
	Cypress Hall:						
7	Section 1	823	R.	do	900	820	4.4
8	Section 2	823	R.	do	800	730	4.4
9	Section 3	823	R.	do	600	540	4.4
	Barroza:						
10	Section 1	824	R.	Sam Robertson	700	640	4.3
11	Section 2	824	R.	do	700	640	4.3
	Port Allen:						
12	Section 5	833	R.	Helgason Brothers	1,100	1,100	4.5
	Limerick:						
13	Section 1	834	R.	do	900	760	4.3
14	Section 2	834	R.	do	1,100	1,100	4.6
15	Section 3	834	R.	do	1,000	1,000	4.6
16	Section 4	834	R.	do	1,000	600	4.6

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Total yardage.
		Crown.	Land slope.	River slope.		Above old levee.	Ground surface.		
	Grand Bay:	*Ft.*				*Feet.*	*Feet.*		*Cubic yards.*
1	Section 1	8	3 to 1	3 to 1	Enlargement.	4.6	24.4	Nov. 24, 1899	13,400.58
2	Section 2	8	3 to 1	3 to 1	do	4.6	28.9	do	11,977.39
3	Section 3	8	3 to 1	3 to 1	do	4.5	28.2	do	14,254.41
	Devall:								
4	Section 1	8	3 to 1	3 to 1	do	3	19.8	Mar. 10, 1900	14,604.55
5	Section 2	8	3 to 1	3 to 1	do	3	19.3	do	13,758.83
6	Section 3	8	3 to 1	3 to 1	do	3.2	19.1	do	14,057.75
	Cypress Hall:								
7	Section 1	8	3 to 1	3 to 1	do	3.1	19.2	do	15,877.53
8	Section 2	8	3 to 1	3 to 1	do	3	21.4	do	15,821.24
9	Section 3	8	3 to 1	3 to 1	do	2.9	22.3	do	13,322.23
	Barroza:								
10	Section 1	8	3 to 1	3 to 1	do	2.8	22.7	Oct. 5, 1899	15,042.06
11	Section 2	8	3 to 1	3 to 1	do	2.8	22.4	do	13,555.77
	Port Allen:								
12	Section 5	8	3 to 1	3 to 1	do	2.3	17.3	Jan. 30, 1900	21,116.88
	Limerick:								
13	Section 1	8	3 to 1	3 to 1	do	2.3	17.9	Dec. 23, 1899	13,401.85
14	Section 2	8	3 to 1	3 to 1	do	2.2	18.4	do	14,062.70
15	Section 3	8	3 to 1	3 to 1	do	2.2	18.6	do	12,381.26
16	Section 4	8	3 to 1	3 to 1	do	2	17.6	do	1,242.82

Fourth district levees, 1899–1900—Continued.

ATCHAFALAYA LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition of contract.
			Least.	Greatest.	Average.		
	Grand Bay:	*Cents.*	*Feet.*	*Feet.*	*Feet.*		
1	Section 1	24.60	1,520	1,830	1,670	Caving	45 per cent completed.
2	Section 2	24.60	1,830	2,300	2,200	do	48 per cent completed.
3	Section 3	24.60	2,300	2,340	2,320	do	43 per cent completed.
	Devall:						
4	Section 1	15.47	960	1,400	1,180	do	Nothing done.
5	Section 2	15.47	1,340	1,400	1,370	do	Do.
6	Section 3	15.47	900	1,340	1,160	do	Do.
	Cypress Hall:						
7	Section 1	15.47	900	1,080	960	do	Do.
8	Section 2	15.47	1,080	1,120	1,080	do	Do.
9	Section 3	15.47	1,120	1,230	1,170	do	Do.
	Barroza:						
10	Section 1	22.50	1,230	1,310	1,270	do	Do.
11	Section 2	22.50	1,040	1,310	1,170	do	2 per cent completed.
	Port Allen:						
12	Section 5	12.80	295	320	310	do	7 per cent completed.
	Limerick:						
13	Section 1	14.20	295	475	350	do	Nothing done.
14	Section 2	14.20	460	570	520	do	Do.
15	Section 3	14.20	450	540	520	do	60 per cent completed.
16	Section 4	14.20	190	450	320	Washing	8 per cent completed.

LAFOURCHE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Jamestown:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	898	R.	Donovan & Daley	1,167	1,160	4
2	Section 2	898	R.	do	1,000	950	4
	Oak Alley:						
3	Section 2	908	R.	H. L. Linnan	1,000	1,150	3.9
4	Section 3	908	R.	do	1,102	1,200	3.9
5	Section 5	908	R.	do	1,478	1,700	3.9
	Willow Grove:						
6	Section 1	916	R.	Alb. J. Lacaze	1,695	1,330	3.8
	Alliance:						
7	Section 2	920	R.	do	2,349	2,270	3.6
	Hymelia-Killona:						
8	Section 1	930	R.	Hayes Bros	2,808	3,000	3.6
9	Section 2	930	R.	do	2,307	2,200	3.6
10	Section 3	930	R.	do	2,287	2,200	3.6
11	Section 4	930	R.	do	1,802	1,800	3.6
12	Section 5	930	R.	do	2,365	2,300	3.6
	Pelican-Flagtown:						
13	Section 5	936	R.	do	2,879	2,800	3
	Ashton:						
14	Section 2	940	R.	do	1,171	1,130	3.4
15	Lone Star	942	R.	do	2,047	1,900	3.4
	Louisa:						
16	Section 2	943	R.	Donovan & Daley	3,200	3,200	2.7
17	Coopersville	944	R.	J. A. Andrews & Son	2,632	2,500	2.9

Fourth district levees, 1899–1900—Continued.

LAFOURCHE LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Jamestown:	*Feet.*				*Feet.*	*Feet.*	1899.	1900.
1	Section 1	8	3 to 1	3 to 1	Enlargement.	3.3	14	Nov. 16	Mar. 12
2	Section 2	8	3 to 1	3 to 1	....do...	3.1	14.6	....do...	Feb. 21
	Oak Alley:								
3	Section 2	8	3 to 1	3 to 1	....do...	2.6	14.9	Sept. 29	Jan. 5
4	Section 3	8	3 to 1	3 to 1	....do...	2.7	15.2	....do...	Feb. 1:
5	Section 5	8	3 to 1	3 to 1	....do...	2.7	14.6	....do...	Mar. 24
	Willow Grove:								
6	Section 1	8	3 to 1	3 to 1	....do...	2.8	11.6	Nov. 27	Mar. 21
	Alliance:								
7	Section 2	8	3 to 1	3 to 1	....do...	2	11	Oct. 5 1898.	Jan. 6 1899.
	Hymelia-Killona:								
8	Section 1	8	3 to 1	3 to 1	....do...	2	11.6	Oct. 1	Nov. 22
9	Section 2	8	3 to 1	3 to 1	....do...	1.7	9.6	....do...	Dec. 14 1900.
10	Section 3	8	3 to 1	3 to 1	....do...	2	10.6	....do...	Feb. 15
11	Section 4	8	3 to 1	3 to 1	....do...	2	10.9	....do...	Do.
12	Section 5	8	3 to 1	3 to 1	....do...	1.9	10.9	....do...	Mar. 20 1899.
	Pelican-Flagtown:								
13	Section 5	8	3 to 1	3 to 1	....do...	1.5	13	....do... 1900.	Sept. 15 1900.
	Ashton:								
14	Section 2	8	3 to 1	3 to 1	....do...	2.3	10.7	Jan. 30 1898.	Apr. 25
15	Lone Star	8	3 to 1	3 to 1	....do...	2.3	11.8	Oct. 1	Feb. 23 1899.
	Louisa:								
16	Section 2	8	3 to 1	3 to 1	....do...	1.2	11	....do...	Aug. 8
17	Coopersville	8	3 to 1	3 to 1	....do...	1.5	10.6	....do...	Sept. 15

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Jamestown:	*Cubic yards.*	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	11,676.92	14.90	$1,739.86	350	450	410	Caving.
2	Section 2	10,399.49	14.90	1,549.52	190	410	350	Do.
	Oak Alley:							
3	Section 2	15,966.27	14.50	2,315.11	460	600	550	Do.
4	Section 3	15,131.17	14.50	2,194.02	600	760	710	Do.
5	Section 5	15,411.55	14.50	2,234.67	150	380	220	Stationary.
	Willow Grove:							
6	Section 1	13,160.09	10.00	1,316.01	185	265	250	Washing.
	Alliance:							
7	Section 2	16,288.18	12.75	2,076.75	120	320	230	Do.
	Hymelia-Killona:							
8	Section 1	18,876.04	11.75	2,217.93	750	2,000	1,200	Making.
9	Section 2	18,398.78	11.75	2,161.86	350	750	450	Stationary.
10	Section 3	18,080.21	11.75	2,124.42	75	350	170	Washing.
11	Section 4	17,323.35	11.75	2,035.49	150	250	180	Do.
12	Section 5	18,619.73	11.75	2,187.82	150	250	200	Do.
	Pelican-Flagtown:							
13	Section 5	26,265.20	12.75	3,348.81	350	1,100	800	Making.
	Ashton:							
14	Section 2	10,473.87	10.90	1,141.65	200	280	260	Caving.
15	Lone Star	16,972.84	18.00	3,055.11	190	330	259	Do.
	Louisa:							
16	Section 2	18,867.27	13.90	2,622.55	167	260	200	Do.
17	Coopersville	11,007.69	14.75	1,623.63	260	360	310	Do.

Fourth district levees, 1899–1900—Continued.

LAFOURCHE LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Delogny:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	906	R.	Donovan & Daley	1,171	1,210	3.9
2	Section 2	906	R.	do	1,100	1,140	3.9
3	Section 3	906	R.	do	1,000	1,030	3.9
4	Section 4	906	R.	do	907	1,020	3.9
5	Section 5	907	R.	do	700	600	3.9
	Oak Alley:						
6	Section 1	908	R.	H. L. Linnan	987	1,180	3.9
7	Section 4	908	R.	do	1,000	940	3.9
8	Ashton, section 1	940	R.	Hayes Brothers	969	920	3.4
	Ellington:						
9	Section 1	941	R.	do	1,488	1,490	3.4
10	Section 2	941	R.	do	1,534	1,540	3.4
	Alice:						
11	Section 1	946	R.	F. H. McLaughlin	2,808	3,050	3.3
12	Section 2	946	R.	do	2,000	2,170	3.3
13	Section 3	946	R.	do	1,551	1,620	3.3
	Willswood:						
14	Section 1	951	R.	W. F. Barbour & Son	1,444	1,400	3.3
15	Section 2	951	R.	do	1,400	1,350	3.3
16	Section 3	951	R.	do	1,482	1,440	3.3

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Total yardage.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Delogny:	*Feet.*				*Feet.*	*Feet.*	1900.	*Cu. yds.*
1	Section 1	8	3 to 1	3 to 1	Enlargement.	1.9	13.3	Mar. 8	10,224.12
2	Section 2	8	3 to 1	3 to 1	do	2.3	15.1	do	10,653.39
3	Section 3	8	3 to 1	3 to 1	do	2.6	15.8	do	10,045.18
4	Section 4	8	3 to 1	3 to 1	do	2.4	16.3	do	10,376.38
5	Section 5	8	3 to 1	3 to 1	do	2.7	15.8	do	9,531.12
	Oak Alley:							1899.	
6	Section 1	8	3 to 1	3 to 1	do	2.7	16.1	Sept. 29	15,322.35
7	Section 4	8	3 to 1	3 to 1	do	2.4	15.1	do	13,565.37
8	Ashton, section 1	.....	.....	.....	.....	2.4	12.3	1900. Jan. 30	9,662.95
	Ellington:								
9	Section 1	8	3 to 1	3 to 1	Enlargement.	2.4	12.3	do	11,391.97
10	Section 2	8	3 to 1	3 to 1	do	1.7	11.8	do	11,447.60
	Alice:								
11	Section 1	8	3 to 1	3 to 1	do	1.4	10.3	Mar. 10	13,850.67
12	Section 2	8	3 to 1	3 to 1	do	1.8	11.1	do	13,553.14
13	Section 3	8	3 to 1	3 to 1	do	2	12.3	do	13,493.47
	Willswood:								
14	Section 1	8	3 to 1	3 to 1	do	1.8	10.3	Apr. 14	9,123.59
15	Section 2	8	3 to 1	3 to 1	do	2.2	10	do	9,630.59
16	Section 3	8	3 to 1	3 to 1	do	2.6	10.6	do	9,525.49

Fourth district levees, 1899–1900—Continued.

LAFOURCHE LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition of contract.
			Least.	Greatest.	Average.		
	Delogny:	*Cents.*	*Feet.*	*Feet.*	*Feet.*		
1	Section 1	15.00	557	700	610	Caving	Nothing done.
2	Section 2	15.00	557	620	570	do	Do.
3	Section 3	15.00	480	660	530	do	Do.
4	Section 4	15.00	480	690	550	do	Do.
5	Section 5	15.00	480	600	460	do	Do.
	Oak Alley:						
6	Section 1	14.50	480	460	450	do	67 per cent completed
7	Section 4	14.50	380	770	670	Washing	95 per cent completed
8	Ashton, section 1	10.90	200	290	260	Caving	Do.
	Ellington:						
9	Section 1	10.40	140	190	170	Washing	Nothing done.
10	Section 2	10.40	140	170	160	do	Do.
	Alice:						
11	Section 1	9.85	220	290	260	do	Do.
12	Section 2	9.85	140	220	180	do	75 per cent completed.
13	Section 3	9.85	140	170	165	do	13 per cent completed.
	Willswood:						
14	Section 1	8.80	112	140	126	do	Nothing done.
15	Section 2	8.80	140	280	200	do	Do.
16	Section 3	8.80	140	210	190	do	28 per cent completed.

BARATARIA LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Upper Magnolia:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	979	R.	F. H. McLaughlin	2,251	1,500	3.2
2	Section 2	979	R.	Robert McNamara	2,382	2,550	3.2
3	Little Rock	980	R.	H. G. Seeligson	1,776	1,560	3.2
4	Belle Chasse	982	R.	F. H. McLaughlin	4,532	2,730	3.2
5	St. Ann	985	R.	Michael Cullen	2,782	3,026	3.1
6	Alliance	998	R.	do	2,180	2,200	3
7	St. Rosalie	999	R.	Wade Bros. Const'n Co	4,734	4,874	3
8	St. Rosalie to Ironton	1,000	R.	Michael Cullen	2,690	2,900	3
9	Magnolia	1,018	R.	Joseph Hingle, jr	4,306	4,700	2.3
10	Ballay to Orange Farm, section 4.	1,023	R.	Victor Adema	2,698	1,510	2.5
	Orange Farm:						
11	Section 1	1,024	R.	Michael Cullen	1,464	1,100	3
12	Section 2	1,024	R.	John Cleary	2,341	1,900	3
13	Nairn, section 2	1,025	R.	Dilworth Scudder Dredging Company.	3,228	4,125	2.5
14	Nairn extension	1,025	R.	Michael Cullen	1,225	1,650	3
15	Pelas	1,032	R.	Robert McNamara	1,616	1,500	2.9
16	Rodey	1,035	R.	do	3,308	3,100	2.8
17	Rodey extension	1,035	R.	P. Harnan	3,170	3,250	2.8
18	Reddick	1,038	R.	Gus. Schoenberger	1,544	1,200	2.8
19	Booth	1,039	R.	Robert McNamara	2,021	1,700	2.8

Fourth district levees, 1899–1900—Continued.

BARATARIA LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Upper Magnolia:	*Feet.*				*Feet.*	*Feet.*	1899.	1900.
1	Section 1	8	3 to 1	3 to 1	Enlargement.	2	8	Aug. 18	Feb. 2
2	Section 2	8	3 to 1	3 to 1	....do...	2.1	8.2	....do...	Dec. 2
3	Little Rock	8	3 to 1	3 to 1	....do...	1.9	9.4	1899. ....do...	Oct. 31
4	Belle Chasse	8	3 to 1	3 to 1	....do...	1.9	10.5	1900. ....do...	Feb. 1
5	St. Ann	8	3 to 1	3 to 1	....do...	2.3	10.4	1898. Oct. 27	1899. Oct. 16
6	Alliance	8	3 to 1	3 to 1	....do...	2.2	9.2	1899. Dec. 5	1900. Feb. 2
7	St. Rosalie	8	3 to 1	3 to 1	New	8.3	8.3	1898. Nov. 19	1899. Nov. 6
8	St. Rosalie to Ironton	8	3 to 1	3 to 1	Enlargement.	1.9	8.5	1899. Dec. 2	1900. Feb. 20
9	Magnolia	8	3 to 1	3 to 1	....do...	0.7	8.3	1897. Dec. 29	1899. Oct. 25
10	Ballay to Orange Farm, section 4.	8	3 to 1	3 to 1	New and enlargement.	1.8	6.5	Sept. 17	Dec. 2
	Orange Farm:							1899.	1900.
11	Section 1	8	3 to 1	3 to 1	New	7.5	7.5	Aug. 18	Jan. 5
12	Section 2	8	3 to 1	3 to 1	....do...	6.6	6.6	....do...	Jan. 8
13	Nairn, section 2	8	3 to 1	3 to 1	Enlargement.	2.5	6	1897. Dec. 29	1899. June 20
14	Nairn extension	8	3 to 1	3 to 1	....do...	3.4	6.5	1899. Nov. 27	1900. Feb. 17
15	Pelas	8	3 to 1	3 to 1	....do...	2.3	7.5	1898. Oct. 27	Jan. 23
16	Rodey	8	3 to 1	3 to 1	....do...	2.2	6.6	....do...	Jan. 28
17	Rodey extension	8	3 to 1	3 to 1	....do...	1.6	6.9	1899. Dec. 12	Mar. 1
18	Reddick	8	3 to 1	3 to 1	New	6.4	6.4	Aug. 18	Jan. 8
19	Booth	8	3 to 1	3 to 1	Enlargement.	2.2	6.9	1898. Oct. 27	1899. Nov. 22

Fourth district levees, 1899–1900—Continued.

BARATARIA LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Upper Magnolia:	*Cu. yds.*	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	12,728.02	16.75	$2,131.95	200	310	280	Making.
2	Section 2	12,189.32	16.00	1,950.29	80	270	155	Do.
3	Little Rock	6,592.15	14.90	982.23	100	215	130	Washing.
4	Belle Chasse	30,570.78	16.75	5,120.61	278	427	335	Caving.
5	St. Ann	12,601.73	13.25	1,669.73	105	235	220	Making.
6	Alliance	12,629.18	14.90	1,881.74	110	140	185	Caving.
7	St. Rosalie	46,788.73	13.50	6,316.48	100	150	127	Stationary
8	St. Rosalie to Ironton	20,326.78	15.90	3,231.94	120	180	135	Do.
9	Magnolia	16,255.31	12.20	1,983.14	139	350	220	Making.
10	Ballay to Orange Farm, section 4.	14,656.42	11.25	1,648.85	78	150	110	Washing.
	Orange Farm:							
11	Section 1	12,975.97	15.45	2,004.79	190	280	260	Caving.
12	Section 2	15,557.78	14.78	2,314.22	240	320	260	Do.
13	Nairn, section 2	14,094.72	12.25	1,726.00	75	150	130	Washing and making.
14	Nairn extension	8,235.74	14.90	1,227.18	280	380	320	Making.
15	Pelas	6,931.01	13¾	961.68	105	121	110	Washing.
16	Rodey	16,785.05	15.50	2,601.67	200	255	240	Making.
17	Rodey extension	12,993.62	14.90	1,936.05	75	255	172	Do.
18	Reddick	10,400.35	14.50	1,508.05	160	190	170	Caving.
19	Booth	9,371.92	13.75	1,288.64	80	130	90	Washing.

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
					Feet.	*Feet.*	*Feet.*
1	Section 7	836	L.	Israel R. Bobbitt	1,921	1,921	3.7
2	Section 9	836	L.	....do	1,946	1,946	3.9
3	Section 72, extension	854	L.	Clark & Reagan	171	100	3.4
4	Section 73	855	L.	....do	1,789	1,789	3.4
5	Section 78	855	L.	George Byrne	1,691	1,691	3.3
6	Section 81	856	L.	Clark & Reagan	767	1,000	4.3
7	Section 82	856	L.	....do	911	1,030	4.2
	Landry:						
8	Section 1	856	L.	M. L. Linnan	1,404	1,700	4
9	Section 2	856	L.	....do	1,800	1,550	4
10	Section 3	856	L.	....do	1,100	1,300	4
11	Section 4	856	L.	....do	1,000	1,250	4
12	Section 5	856	L.	....do	1,100	1,200	4
	Mount Olive:						
13	Section 1	857	L.	....do	1,000	1,150	4.3
14	Section 2	857	L.	....do	900	920	4.3
15	Section 3	857	L.	....do	800	700	4.3
16	Section 4	857	L.	....do	900	650	4.3
17	Section 5	857	L.	....do	1,000	1,000	4.3
18	Forlorn Hope: Section 4.	858	L.	Ogden Bros. & Park	1,318	1,290	4.1
	Golden Gate:						
19	Section 1	859	L.	....do	1,092	1,040	4
20	Section 2	859	L.	....do	1,200	1,150	4
21	Section 3	859	L.	....do	1,200	1,000	4
22	Section 4	859	L.	....do	1,200	1,100	4
23	Section 5	859	L.	....do	1,192	1,190	4
24	Section 97	860	L.	Michael Hanick	1,418	1,418	3.2
25	Section 101	862	L.	....do	1,111	1,111	3.1
26	Thiery	864	L.	F. M. McLaughlin	1,231	1,230	4.2
27	Lorio	867	L.	John Pollard	1,020	1,040	4.1
	Point Clear:						
28	Section 3	868	L.	John A. Weber	478	900	3.9
29	Section 4	868	L.	....do	700	1,400	3.9
30	Section 5	868	L.	....do	623	1,100	3.9
	Leper Home:						
31	Section 4	870	L.	James R. Harlow	1,000	980	4.3
32	Section 5	870	L.	....do	1,000	980	4.3
	Hard Times:						
33	Section 1	872	L.	Donovan & Daley	1,200	1,160	4
34	Section 2	872	L.	....do	1,100	1,070	4
35	Section 3	872	L.	....do	1,200	1,160	4
36	Section 4	872	L.	....do	1,200	1,165	4
37	Section 5	872	L.	....do	1,133	1,100	4

Fourth district levees, 1899–1900—Continued.

PONTCHARTRAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Section.			New or enlargement.	Average height—		Date of contract	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
		Feet.				*Feet.*	*Feet.*	1897.	1900.
1	Section 7	8	3 to 1	3 to 1	Enlargement.	2.2	21.2	Sept. 1	May 1
2	Section 9	8	3 to 1	3 to 1	....do...	3.6	22.6	....do...	Apr. 12
								1899.	1899
3	Section 72, extension	8	3 to 1	3 to 1	....do...	1.7	13.4	Feb. 27	July 15
4	Section 73	8	3 to 1	3 to 1	....do...	3.3	14.6	....do...	July 8
5	Section 78	8	3 to 1	3 to 1	....do...	2.8	13.5	Mar. 2	July 28
6	Section 81	8	3 to 1	3 to 1	....do...	2.6	10.8	July 14	Aug. 4
7	Section 82	8	3 to 1	3 to 1	....do...	3	10.3	....do...	Aug. 15
	Landry:								1900.
8	Section 1	8	3 to 1	3 to 1	....do...	2.2	15.6	Oct. 5	Jan. 16
9	Section 2	8	3 to 1	3 to 1	....do...	2.7	14.3	....do...	Mar. 10
10	Section 3	8	3 to 1	3 to 1	....do...	2.7	19.2	....do...	Mar. 10
11	Section 4	8	3 to 1	3 to 1	....do...	2.6	19.5	....do...	Feb. 24
12	Section 5	8	3 to 1	3 to 1	....do...	3	19.7	....do...	Feb. 14
	Mount Olive:								
13	Section 1	8	3 to 1	3 to 1	....do...	2.5	15.4	Sept. 29	Feb. 15
14	Section 2	8	3 to 1	3 to 1	....do...	2.8	16.6	....do...	Jan. 8
15	Section 3	8	3 to 1	3 to 1	....do...	3.1	16.9	....do...	Jan. 5
16	Section 4	8	3 to 1	3 to 1	....do...	3.3	16.8	....do...	Jan. 2
									1899.
17	Section 5	8	3 to 1	3 to 1	....do...	3	16.1	....do...	Dec. 5
								1900.	1900.
18	Forlorn Hope: Section 4	8	3 to 1	3 to 1	....do...	3.1	19.8	Jan. 20	Apr. 6
	Golden Gate:							1899.	
19	Section 1	8	3 to 1	3 to 1	....do...	2.8	14.5	Sept. 29	Mar. 2
20	Section 2	8	3 to 1	3 to 1	....do...	2.9	15.7	....do...	Feb. 16
									1899.
21	Section 3	8	3 to 1	3 to 1	....do...	3	14.6	....do...	Dec. 13
									1900.
22	Section 4	8	3 to 1	3 to 1	....do...	3.2	13.7	....do...	Jan. 30
									1899.
23	Section 5	8	3 to 1	3 to 1	....do...	3.4	13.5	....do...	Nov. 19
								1898.	
24	Section 97	8	3 to 1	3 to 1	....do...	2.6	14	Jan. 5	July 18
25	Section 101	8	3 to 1	3 to 1	....do...	2.6	15.3	....do...	Aug. 15
								1899.	1900.
26	Thiery	8	3 to 1	3 to 1	....do...	2.8	14.3	Oct. 5	Feb. 14
27	Lorio	8	3 to 1	3 to 1	....do...	3.1	13	....do...	Jan. 4
	Point Clear:								
28	Section 3	8	3 to 1	3 to 1	....do...	3.4	14	Nov. 17	Mar. 28
29	Section 4	8	3 to 1	3 to 1	....do...	3.1	14	....do...	Mar. 8
30	Section 5	8	3 to 1	3 to 1	....do...	3.2	15.2	....do...	Feb. 14
	Leper Home:							1900.	
31	Section 4	8	3 to 1	3 to 1	....do...	3.5	15.4	Jan. 2	Mar. 20
32	Section 5	8	3 to 1	3 to 1	....do...	3.6	14.5	....do...	Apr. 20
	Hard Times:							1899.	
33	Section 1	8	3 to 1	3 to 1	....do...	3.2	16.0	Nov. 16	Mar. 10
34	Section 2	8	3 to 1	3 to 1	....do...	3.2	15.3	....do...	Mar. 17
35	Section 3	8	3 to 1	3 to 1	....do...	3.2	15	....do...	Mar. 25
36	Section 4	8	3 to 1	3 to 1	....do...	3.2	15.1	....do...	Mar. 28
37	Section 5	8	3 to 1	3 to 1	....do...	3.2	15	....do...	Mar. 28

Fourth district levees, 1899–1900—Continued.

PONTCHARTAIN LEVEE DISTRICT—Continued.

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
		Cub. yards.	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 7	20,851.55	17	$3,544.76	530	700	620	Caving.
2	Section 9	24,003.04	17	4,080.52	500	760	640	Do.
3	Section 72, extension	1,698.85	13.23	224.76	200	340	270	Do.
4	Section 73	17,351.47	13.23	2,295.60	356	340	270	Do.
5	Section 78	16,874.02	12	2,024.88	225	225	225	Do.
6	Section 81	7,950.38	10.50	833.79	136	220	180	Making.
7	Section 82	7,414.41	10.50	778.51	110	220	140	Do.
	Landry:							
8	Section 1	11,923.87	13	1,550.10	120	157	140	Do.
9	Section 2	12,911.39	13	1,678.48	157	710	540	Stationary
10	Section 3	13,176.17	13	1,712.90	710	840	820	Making.
11	Section 4	11,945.14	13	1,552.87	280	830	470	Do.
12	Section 5	12,401.87	13	1,612.24	280	370	330	Do.
	Mount Olive:							
13	Section 1	13,276.14	14	1,858.52	330	600	470	Do.
14	Section 2	12,356.74	14	1,729.94	600	700	650	Do.
15	Section 3	11,563.49	14	1,618.89	570	700	620	Do.
16	Section 4	11,891.41	14	1,664.80	700	1,180	1,000	Do.
17	Section 5	11,861.03	14	1,660.55	1,160	1,180	1,170	Do.
18	Forlorn Hope: Section 4	15,859.52	11.80	1,792.13	270	560	810	Stationary
	Golden Gate:							
19	Section 1	12,806.51	13.97	1,789.07	157	210	180	Caving.
20	Section 2	12,664.53	13.97	1,769.23	210	285	250	Do.
21	Section 3	12,306.79	13.97	1,719.26	285	425	300	Do.
22	Section 4	12,389.52	13.97	1,730.82	325	430	380	Do.
23	Section 5	13,183.10	13.97	1,841.68	340	440	400	Do.
24	Section 97	14,503.71	14.49	2,116.08	300	410	400	Do.
25	Section 101	11,789.90	14.49	1,790.35	300	320	310	Washing.
26	Thiery	12,876.56	14	1,802.35	180	260	240	Do.
27	Lorio	11,771.05	13.99	1,646.77	80	250	180	Do.
	Point Clear:							
28	Section 3	5,042.68	10.50	529.48	140	140	140	Stationary
29	Section 4	8,237.15	10.50	864.90	100	160	125	Do.
30	Section 5	8,148.98	10.50	855.64	80	112	95	Do.
	Leper Home:							
31	Section 4	13,033.45	11.70	1,524.91	200	280	230	Washing.
32	Section 5	12,798.65	11.70	1,497.44	240	280	260	Do.
	Hard Times:							
33	Section 1	14,001.33	14¼	1,802.67	250	300	280	Do.
34	Section 2	14,177.91	14¼	1,825.41	250	310	290	Do.
35	Section 3	13,794.99	14¼	1,776.10	265	310	280	Do.
36	Section 4	13,732.35	14¼	1,768.04	260	320	280	Do.
37	Section 5	13,471.59	14¼	1,734.47	230	290	260	Do.

Fourth district levees, 1899–1900—Continued.

PONTCHARTRAIN LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
					Feet.	*Feet.*	*Feet.*
	Burtville:						
1	Section 1	847	L.	Mississippi Levee Construction Co.	1,022	571	4.5
2	Section 2	847	L.	do	900	242	4.4
3	Section 3	847	L.	do	800	625	4.4
4	Section 4	847	L.	do	847	329	4.4
5	Section 5	847	L.	do	900	1,015	4.5
	Woodstock:						
6	Section 1	848	L.	do	700	299	4.5
7	Section 2	848	L.	do	500	487	4.4
8	Section 3	848	L.	do	600	583	4.4
9	Section 4	848	L.	do	700	610	4.4
10	Section 5	848	L.	do	700	688	4.4
	Manchac:						
11	Section 1	848	L.	do	800	794	4.4
12	Section 2	848	L.	do	800	792	4.3
13	Section 3	848	L.	do	800	768	4.3
14	Section 4	848	L.	do	900	888	4.3
15	Section 5	848	L.	do	900	811	4.3
	Granada:						
16	Section 1	849	L.	do	800	794	4.3
17	Section 2	849	L.	do	800	762	4.3
18	Section 3	849	L.	do	900	896	4.2
19	Section 4	849	L.	do	900	654	4.2
20	Section 5	849	L.	do	1,000	861	4.2
	Hermitage:						
21	Section 1	850	L.	do	1,000	1,085	4.2
22	Section 2	850	L.	do	1,000	986	4.2
23	Section 3	850	L.	do	1,100	794	4.2
24	Section 4	850	L.	do	900	895	4.2
25	Section 5	850	L.	do	1,100	1,098	4.2
	Towles:						
26	Section 1	851	L.	do	1,300	1,305	4.2
27	Section 2	851	L.	do	1,200	999	4.1
28	Section 3	851	L.	do	1,200	1,050	4.2
	Forlorn Hope:						
29	Section 1	858	L.	Ogden Bros. & Park	1,300	1,265	4.3
30	Section 2	858	L.	do	1,200	1,098	4.2
31	Section 3	858	L.	do	1,200	1,130	4.1
	Point Clear:						
32	Section 1	868	L.	Israel R. Bobbitt	748	789	4.1
33	Section 2	868	L.	do	822	838	4.1
	Leper Home:						
34	Section 1	870	L.	James R. Marlow	1,264	1,228	4.2
35	Section 2	870	L.	do	1,300	1,289	4.2
36	Section 3	870	L.	do	1,200	1,165	4.2
	Indian Camp:						
37	Section 1	871	L.	Donovan & Daley	1,100	1,070	4.2
38	Section 2	871	L.	do	900	885	4.2
39	Section 3	871	L.	do	1,000	980	4.2
40	Section 4	871	L.	do	1,000	980	4.2
41	Section 5	871	L.	do	1,100	1,070	4.2

Fourth district levees, 1899–1900—Continued.

PONTCHARTRAIN LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Section.			New, or enlargement.	Average height.		Date of contract.	Total yardage.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Burtville:	*Feet.*				*Feet.*	*Feet.*	1900.	*Cu. yds.*
1	Section 1	8	3 to 1	3 to 1	Enlargement.	3.7	17.3	Mar. 24	14,381.82
2	Section 2	8	3 to 1	3 to 1	...do....	3.9	17.5	...do....	13,149.48
3	Section 3	8	3 to 1	3 to 1	...do....	4	16.9	...do....	12,831.28
4	Section 4	8	3 to 1	3 to 1	...do....	4.5	16.6	...do....	14,144.48
5	Section 5	8	3 to 1	3 to 1	...do....	3	17.4	...do....	14,490.15
	Woodstock:								
6	Section 1	8	3 to 1	3 to 1	...do....	3	17.8	...do....	12,198.86
7	Section 2	8	3 to 1	3 to 1	...do....	3.6	17.8	...do....	10,737.94
8	Section 3	8	3 to 1	3 to 1	...do....	3.5	17.6	...do....	12,012.90
9	Section 4	8	3 to 1	3 to 1	...do....	3.8	17.5	...do....	11,180.54
10	Section 5	8	3 to 1	3 to 1	...do....	3.7	17.8	...do....	11,066.99
	Manchac:								
11	Section 1	8	3 to 1	3 to 1	...do....	3.6	17.5	...do....	12,418.17
12	Section 2	8	3 to 1	3 to 1	...do....	3.9	17.9	...do....	11,854.81
13	Section 3	8	3 to 1	3 to 1	...do....	3.8	17.8	...do....	11,930.48
14	Section 4	8	3 to 1	3 to 1	...do....	3.5	17.6	...do....	12,805.04
15	Section 5	8	3 to 1	3 to 1	...do....	3.3	17.1	...do....	13,283.36
	Granada:								
16	Section 1	8	3 to 1	3 to 1	...do....	3.7	17.1	...do....	12,425.35
17	Section 2	8	3 to 1	3 to 1	...do....	3.9	16.9	...do....	12,172.28
18	Section 3	8	3 to 1	3 to 1	...do....	3.8	16.5	...do....	13,500.63
19	Section 4	8	3 to 1	3 to 1	...do....	3.6	16.1	...do....	14,137.36
20	Section 5	8	3 to 1	3 to 1	...do....	3.5	15.6	...do....	13,214.02
	Hermitage:								
21	Section 1	8	3 to 1	3 to 1	...do....	3.9	14.3	...do....	12,256.87
22	Section 2	8	3 to 1	3 to 1	...do....	3.6	15.9	...do....	12,884.89
23	Section 3	8	3 to 1	3 to 1	...do....	3.7	14.8	...do....	13,442.19
24	Section 4	8	3 to 1	3 to 1	...do....	3.8	14.7	...do....	12,491.88
25	Section 5	8	3 to 1	3 to 1	...do....	3.9	14.6	...do....	13,523.76
	Towles:								
26	Section 1	8	3 to 1	3 to 1	...do....	3.8	14.3	...do....	16,085.70
27	Section 2	8	3 to 1	3 to 1	...do....	3.7	14.1	...do....	14,602.96
28	Section 3	8	3 to 1	3 to 1	...do....	3.6	14.8	...do....	14,938.00
	Forlorn Hope:								
29	Section 1	8	3 to 1	3 to 1	...do....	3.2	15.3	Jan. 20	15,227.70
30	Section 2	8	3 to 1	3 to 1	...do....	3.4	15.1	...do....	14,718.54
31	Section 3	8	3 to 1	3 to 1	...do....	2.3	19.7	...do....	15,387.92
	Point Clear:								
32	Section 1	8	3 to 1	3 to 1	...do....	3.2	12.5	Apr. 23	8,768.32
33	Section 2	8	3 to 1	3 to 1	...do....	3.1	12.3	...do....	8,213.98
	Leper Home:								
34	Section 1	8	3 to 1	3 to 1	...do....	3.3	14.1	Jan. 2	13,588.21
35	Section 2	8	3 to 1	3 to 1	...do....	3.6	13.4	...do....	13,197.76
36	Section 3	8	3 to 1	3 to 1	...do....	3.8	14.1	...do....	13,855.08
	Indian Camp:							1899.	
37	Section 1	8	3 to 1	3 to 1	...do....	3.4	14.6	Nov. 16	12,954.71
38	Section 2	8	3 to 1	3 to 1	...do....	3.4	17.2	...do....	13,292.26
39	Section 3	8	3 to 1	3 to 1	...do....	3.4	16.3	...do....	12,086.66
40	Section 4	8	3 to 1	3 to 1	...do....	3.4	15.9	...do....	11,963.69
41	Section 5	8	3 to 1	3 to 1	...do....	3.4	16.2	...do....	13,362.14

Fourth district levees, 1899–1900—Continued.

PONTCHARTRAIN LEVEE DISTRICT (UNCOMPLETED LEVEES)—Continued.

No.	Name of levee.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition of contra
			Least.	Greatest.	Average.		
	Burtville:	*Cents.*	*Feet.*	*Feet.*	*Feet.*		
1	Section 1	12.49	590	631	615	Caving	62 per cent completed.
2	Section 2	12.49	520	627	578	do	Nothing done.
3	Section 3	12.49	390	526	453	do	Do.
4	Section 4	12.49	396	415	410	do	Do.
5	Section 5	12.49	425	470	442	do	Do.
	Woodstock:						
6	Section 1	12.49	430	610	525	do	Do.
7	Section 2	12.49	535	660	592	do	Do.
8	Section 3	12.49	432	545	493	do	Do.
9	Section 4	12.49	427	499	468	do	Do.
10	Section 5	12.49	328	429	373	do	Do.
	Manchac:						
11	Section 1	12.49	290	328	314	do	Do.
12	Section 2	12.49	296	398	341	do	Do.
13	Section 3	12.49	319	388	358	do	Do.
14	Section 4	12.49	368	410	384	do	Do.
15	Section 5	12.49	410	489	455	do	Do.
	Granada:						
16	Section 1	12.49	460	489	469	do	Do.
17	Section 2	12.49	490	575	587	do	Do.
18	Section 3	12.49	457	596	521	do	Do.
19	Section 4	12.49	285	457	376	do	Do.
20	Section 5	12.49	280	340	305	do	Do.
	Hermitage:						
21	Section 1	11.52	305	340	327	do	49 per cent completed.
22	Section 2	11.52	298	307	307	do	44 per cent completed.
23	Section 3	11.52	294	351	317	Washing	Nothing done.
24	Section 4	11.52	331	436	388	do	Do.
25	Section 5	11.52	288	439	356	do	Do.
	Towles:						
26	Section 1	11.04	172	288	222	do	Do.
27	Section 2	11.04	125	178	156	do	Do.
28	Section 3	11.04	155	220	182	do	Do.
	Forlorn Hope:						
29	Section 1	10.50	624	915	764	Making	Do.
30	Section 2	10.50	450	627	543	do	Do.
31	Section 3	10.50	510	680	570	Stationary	54 per cent completed.
	Point Clear:						
32	Section 1	9.95	210	305	252	do	Nothing done.
33	Section 2	9.95	198	215	201	do	Do.
	Leper Home:						
34	Section 1	11.70	130	165	152	Washing	70 per cent completed.
35	Section 2	11.20	168	236	197	do	Nothing done.
36	Section 3	11.70	182	230	201	do	59 per cent completed.
	Indian Camp:						
37	Section 1	12.90	190	250	220	do	8 per cent completed.
38	Section 2	12.90	200	230	220	do	7 per cent completed.
39	Section 3	12.90	200	220	210	do	62 per cent completed.
40	Section 4	12.90	220	240	230	do	23 per cent completed.
41	Section 5	12.90	220	300	260	do	67 per cent completed.

Fourth district levees, 1899–1900—Continued.

LAKE BORGNE LEVEE DISTRICT.

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
	Chalmette:				*Feet.*	*Feet.*	*Feet.*
1	Section 1	972	L.	L. F. Roy	3,000	2,800	3.1
2	Section 2	972	L.	Charles H. Smith	2,400	2,950	3.1
3	Corinne, secs. 1 and 2	973	L.	George Jurgens	7,200	6,650	3.2
4	Poydras, section 2	977	L.	John F. Meyer	2,792	2,150	3.2
5	Cærnarvon, secs. 2 and 3.	977	L.	Thomas Egan, jr	1,250	900	3.2
	Kenilworth:						
6	Section 1	980	L.	Narcisse Mereaux	1,456	1,200	3.2
7	Sections 3 and 4	980	L.	Charles H. Smith	2,158	2,400	3.1
8	St. Clair	982	L.	Chas. G. Daunoy	9,640	10,210	3.2
9	Hary	988	L.	F. M. McLaughlin	1,451	1,250	3.1
10	Bertrandville	991	L.	Chas. G. Daunoy	400	400	3.1
	Harris:						
11	Section 1	1,025	L.	John Cleary	2,400	1,600	2.8
12	Section 2	1,025	L.	.....do	2,864	2,100	2.8

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Work completed.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
	Chalmette:	*Feet.*				*Feet.*	*Feet.*	1899.	1899.
1	Section 1	8	3 to 1	3 to 1	Enlargement.	1.7	7.4	Aug. 17	Nov. 28
2	Section 2	8	3 to 1	3 to 1	....do...	1.5	11.6	....do...	Nov. 30
								1898.	
3	Corinne, secs. 1 and 2	8	3 to 1	3 to 1	....do...	1.8	11	Oct. 22	Do.
4	Poydras, section 2	8	3 to 1	3 to 1	....do...	2.3	13.6	....do...	Dec. 30
5	Cærnarvon, secs. 2 and 3.	8	3 to 1	3 to 1	New....	13.5	13.5	....do...	Nov. 4
	Kenilworth:							1899.	1900.
6	Section 1	8	3 to 1	3 to 1	Enlargement.	2.6	11.8	Dec. 1	Jan. 25
7	Sections 3 and 4	8	3 to 1	3 to 1	....do...	2.8	11.3	Aug. 18	Mar. 29
								1896.	
8	St. Clair	8	3 to 1	3 to 1	....do...	2.6	7.7	Oct. 26	Mar. 10
								1899.	1899.
9	Hary	8	3 to 1	3 to 1	New....	9.3	9.3	Sept. 12	Oct. 25
								1896.	1900.
10	Bertrandville	8	3 to 1	3 to 1	Enlargement.	1.5	8.2	Oct. 26	Jan. 6
								1899.	
	Harris:								
11	Section 1	8	3 to 1	3 to 1	New....	6.4	6.4	Sept. 14	Mar. 10
12	Section 2	8	3 to 1	3 to 1	....do...	6.2	6.2	....do...	Jan. 3

No.	Name of levee.	Total yardage paid for.	Price per cubic yard.	Total cost.	Distance from center of levee to river bank.			Nature of bank.
					Least.	Greatest.	Average.	
	Chalmette:	*Cubic yards.*	*Cents.*		*Feet.*	*Feet.*	*Feet.*	
1	Section 1	12,025.39	14.75	$1,773.75	130	270	200	Making.
2	Section 2	13,767.91	15.90	2,189.10	220	280	250	Do.
3	Corinne, secs. 1 and 2	37,537.59	14.74	5,533.04	110	630	231	Do.
4	Poydras, section 2	14,093.30	44.90	2,099.90	245	420	310	Caving.
5	Cærnarvon, secs. 2 and 3.	28,958.75	16.00	4,633.40	355	370	359	Do.
	Kenilworth:							
6	Section 1	9,470.36	14.90	1,411.09	110	235	160	Stationary.
7	Sections 3 and 4	17,438.50	14.90	2,598.34	140	200	160	Caving.
8	St. Clair	47,215.81	11.40	5,382.60	80	655	400	Making.
9	Hary	16,504.92	13.50	2,228.16	160	220	180	Stationary.
10	Bertrandville	2,474.86	12.00	296.98	60	60	60	Making.
	Harris:							
11	Section 1	16,121.31	13.50	2,176.37	300	440	380	Caving.
12	Section 2	17,623.89	14.50	2,555.46	250	380	320	Do.

Fourth district levees, 1899–1900—Continued.

LAKE BORGNE LEVEE DISTRICT (UNCOMPLETED LEVEES).

No.	Name of levee.	Miles below Cairo.	Bank.	Contractor.	Length of line.	Length of axis of river covered.	Grade of levee above highest known water.
					Feet.	*Feet.*	*Feet.*
1	Kenilworth, section 2...	979	L.	Charles H. Smith	1,300	1,300	3.2
2	Mon Plaisir	984	L.	Charles G. Daunoy	5,300	5,188	3.1

No.	Name of levee.	Section.			New or enlargement.	Average height.		Date of contract.	Total yardage.
		Crown.	Land slope.	River slope.		Above old levee.	Above ground surface.		
		Feet.				*Feet.*	*Feet.*		*Cu. yds.*
1	Kenilworth, section 2...	8	3 to 1	3 to 1	Enlargement.	2.9	13.1	1899. Aug. 18 1896.	11,781.97
2	Mon Plaisir.....	8	3 to 1	3 to 1	....do...	2.1	8	Oct. 26	23,705.41

No.	Name of levee.	Price per cubic yard.	Distance from center of levee to river bank.			Nature of bank.	Condition of contract.
			Least.	Greatest.	Average.		
		Cents.	*Feet.*	*Feet.*	*Feet.*		
1	Kenilworth, section 2...	14.90	180	220	200	Caving	57 per cent completed.
2	Mon Plaisir.....	11.40	122	242	190	Stationary..	24 per cent completed.

Summary of levees built from May 1, 1899, to May 1, 1900.

	Lower Tensas Levee district.	Atchafalaya Levee district.	Lafourche Levee district.	Barataria Levee district.	Pontchartrain Levee district.	Lake Borgne Levee district.	Total.
Earthwork.....cu. yds..	1,264,649.03	646,004.79	272,918.65	292,684.51	466,140.23	233,232.59	3,175,629.80
Embankment, linear feet..	44,447	38,926	21,541	50,245	41,316	37,013	233,488
Axis of river covered, linear feet.....	50,487	36,375	22,100	47,075	43,481	34,610	234,128

Statement of yardage of levee work constructed by the United States and others in the Fourth district, Mississippi River.

	Levee districts.					
	Lower Tensas.	Atchafalaya.	Lafourche.	Barataria.	Pontchartrain.	Lake Borgne.
	Cub. yds.	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*	*Cub. yds.*
Aggregate number of cubic yards in levees on the Mississippi River, May 1, 1899.....	15,227,072	16,527,388	6,868,722	2,456,027	12,443,772	2,834,743
Added by the United States up to May 1, 1900.....	1,264,649	646,005	272,919	292,685	466,140	233,233
Added up to May 1, 1900, by State and district levee boards	449,323	958,476	261,251	61,698	64,237	160,861
Total.....	16,941,044	18,131,869	7,402,892	2,810,410	12,974,149	3,228,837
Lost by abandonment from May 1, 1899, to May 1, 1900, by the United States.....	830,875	50,200	.....	47,100	.....	84,700
By the State and others....	385,650	344,000	211,000	18,000	.....	157,300
Aggregate remaining May 1, 1900.....	15,725,019	17,737,669	7,191,892	2,745,310	12,974,149	3,086,837

Percentage of length of existing levee system built in whole or in part by the United States.

Name of district.	1894.	1895.	1896.	1897.	1898.	1899.	1900.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Lower Tensas	52	52	59	63	66	72	71
Atchafalaya	16.8	43	47	68	65	67	68
Lafourche	14.4	28.8	54	61	61	62	75
Barataria	12.8	19.4	30	43	50	54	63
Pontchartrain	34.6	43.3	63	74	75	77	80
Lake Borgne	10.2	18	53	60	65	66	66.5

Percentage of total length of existing levee system, Fourth district, Mississippi River improvement, built in whole or in part by the United States.

	Per cent.		Per cent.
1894	26.2	1898	65
1895	36.6	1899	66
1896	52	1900	67.2
1897	63		

LOWER TENSAS LEVEE DISTRICT.

The amount expended from June 30, 1899, to June 30, 1900, is $235,007.25, distributed as follows:

Office expenses (main office)	$1,171.47
Other administrative expenses	7,929.56
Construction of levees (contracts)	200,827.82
Repairs to levees	4,259.49
Surveys	2,646.16
Repairs to plant	3.00
New plant	6.60
Miscellaneous	578.01
Clearing right of way, Evergreen-Bondurant Levee	11,082.62
Protection of levees	6,502.52
Total	235,007.25

Money statement.

July 1, 1899, balance unexpended		$277,018.91
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900		110,000.00
		387,018.91
June 30, 1900, amount expended during fiscal year		235,007.25
July 1, 1900, balance unexpended		152,011.66
July 1, 1900, outstanding liabilities	$50.27	
July 1, 1900, amount covered by uncompleted contracts	39,290.25	
		39,340.52
July 1, 1900, balance available		112,671.14

ATCHAFALAYA LEVEE DISTRICT.

The amount expended from June 30, 1899, to June 30, 1900, is $109,772.73, distributed as follows:

Office expenses (main office)	$2,590.31
Other administrative expenses	6,575.25
Construction of levees (contracts)	90,508.41
Repairs to levees	7,021.05
Surveys	1,077.09
Repairs to plant	11.32
New plant	20.50
Miscellaneous	2.88
Protection of levees	1,965.92
Total	109,772.73

Money statement.

July 1, 1899, balance unexpended		$175,036.72
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900		55,000.00
		230,036.72
June 30, 1900, amount expended during fiscal year		109,772.73
July 1, 1900, balance unexpended		120,263.99
July 1, 1900, outstanding liabilities	$1,601.14	
July 1, 1900, amount covered by uncompleted contracts	55,143.58	
		56,744.72
July 1, 1900, balance available		63,519.27

LAFOURCHE LEVEE DISTRICT.

The amount expended from June 30, 1899, to June 30, 1900, is $50,786.76, distributed as follows:

Office expenses (main office)	$2,171.41
Other administrative expenses	3,731.00
Construction of levees (contracts)	39,179.46
Repairs to levees	3,900.55
Surveys	542.31
Repairs to plant	15.10
Protection of levees	1,246.93
Total	50,786.76

Money statement.

July 1, 1899, balance unexpended		$88,354.00
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900		28,000.00
		116,354.00
June 30, 1900, amount expended during fiscal year		50,786.76
July 1, 1900, balance unexpended		65,567.24
July 1, 1900, outstanding liabilities	$516.41	
July 1, 1900, amount covered by uncompleted contracts	16,715.01	
		17,231.42
July 1, 1900, balance available		48,335.82

BARATARIA LEVEE DISTRICT.

The amount expended from June 30, 1899, to June 30, 1900, is $49,161.28, distributed as follows:

Office expenses (main office)	$539.23
Other administrative expenses	3,427.63
Construction of levees (contracts)	40,343.80
Repairs to levees	3,141.27
Surveys	290.55
New plant	93.87
Protection of levees	1,324.93
Total	49,161.28

Money statement.

July 1, 1899, balance unexpended		$57,785.04
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900		14,000.00
		71,785.04
June 30, 1900, amount expended during fiscal year		49,161.28
July 1, 1900, balance unexpended		22,623.76
July 1, 1900, outstanding liabilities	$1,138.47	
July 1, 1900, amount covered by uncompleted contracts	5,014.43	
		6,152.90
July 1, 1900, balance available		16,470.86

PONTCHARTRAIN LEVEE DISTRICT.

The amount expended from June 30, 1899 to June 30, 1900, is $93,217.97, distributed as follows:

Office expenses (main office)	$3,601.90
Other administrative expenses	5,111.86
Construction of levees (contracts)	74,700.27
Repairs to levees	6,159.93
Surveys	656.10
Protection of levees	2,987.91
Total	93,217.97

Money statement.

July 1, 1899, balance unexpended		$159,975.94
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900		50,000.00
		209,975.94
June 30, 1900, amount expended during fiscal year		93,217.97
July 1, 1900, balance unexpended		116,757.97
July 1, 1900, outstanding liabilities	$971.49	
July 1, 1900, amount covered by uncompleted contracts	51,841.12	
		52,812.61
July 1, 1900, balance available		63,945.36

LAKE BORGNE LEVEE DISTRICT.

The amount expended from June 30, 1899 to June 30, 1900, is $34,854.98, distributed as follows:

Office expenses (main office)	$479.32
Other administrative expenses	3,103.98
Construction of levees (contracts)	27,170.70
Repairs to levees	3,156.63
Surveys	167.50
Miscellaneous	8.17
Protection of levees	768.68
Total	34,854.98

Money statement.

July 1, 1899, balance expended		$45,527.34
June 27, 1900, amount allotted from appropriation, sundry civil act of June 6, 1900		14,500.00
		60,027.34
June 30, 1900, amount expended during fiscal year		34,854.98
July 1, 1900, balance unexpended		25,172.36
July 1, 1900, outstanding liabilities	$289.84	
July 1, 1900, amount covered by uncompleted contracts	7,900.54	
		8,190.38
July 1, 1900, balance available		16,981.98

The following maps and appendixes accompany this report:

Plate I. Revetment in Kempe Bend.
Plate II. Revetment in Giles Bend.
Plate III. Bank line in Giles Bend.
Plate IV. Lower Tensas and Homochitto Levee districts.
Plate V. Atchafalaya, Lafourche, and Pontchartrain Levee districts.
Plate VI. Barataria and Lake Borgne Levee districts.
Appendix A. Statement of value of plant.
Appendix B. Commercial statistics.

Appendix C. List of civilian engineers.
Appendix D. Report of H. S. Douglas, assistant engineer, on Kempe Bend, Natchez, and Vidalia harbors, and care and preservation of plants.
Appendix E. Report of A. F. Woolley, jr., assistant engineer, on Atchafalaya and Red rivers, Louisiana.
Appendix F. Report of A. F. Woolley, jr., assistant engineer, on concrete ballast.
Appendix G. Abstract of proposals.
Appendix H. Abstract of contracts in force.

Very respectfully, your obedient servant,

GEO. MCC. DERBY,
Major, Corps of Engineers.

Col. GEO. L. GILLESPIE,
Corps of Engineers, U. S. A.,
President Mississippi River Commission.

APPENDIX 5 A.

Approximate value of plant belonging to the United States and used upon the improvement of the Mississippi River, fourth district, May 1, 1900.

Class of property.	Value.	Class of property.	Value.
Steam launch Ruby	$1,200	One dry dock	$800
Tug General Comstock	6,000	Forty-eight skiffs	450
Tug Tilda	3,600	Tools and appliances	20,000
Tug General A. A. Humphreys	23,000	Office furniture	3,500
Steamer General John Newton	30,000	Surveying instruments	4,000
Dredge The Ram	50,000	Drawing instruments	200
One pile driver	900	Railway cars and track	500
Five quarter boats	10,530		
Twenty-five barges	32,400	Total	187,380
One warehouse barge	300		

APPENDIX 5 B.

Foreign commerce, port of New Orleans.

The statistics relating to the foreign commerce of the port of New Orleans were kindly furnished by Hon. A. T. Wimberly, collector of customs:

Vessels.	Entrances.			Clearances.		
	1897-98.	1898-99.	1899-1900.	1897-98.	1898-99.	1899-1900.
Steam	1,282	1,198	1,418	1,287	1,207	1,401
Sail	65	126	121	61	112	108
Total	1,347	1,324	1,539	1,348	1,319	1,509

Total tonnage of above.

1897-98	4,236,663
1898-99	3,848,736
1899-1900	4,467,308

Exports and imports.

	1898.	1899.	1900.
Exports:			
Total value of exports of foreign merchandise to foreign countries	$546,378.00	$1,304,140.00	$1,189,157.00
Total value of exports of domestic merchandise to foreign countries	104,965,121.00	89,803,442.00	111,486,365.00
Total	105,511,499.00	91,107,582.00	112,675,522.00
Imports:			
Total value of imports from foreign countries—			
Free	5,916,768.00	4,528,576.00	5,761,328.00
Dutiable	5,934,902.00	5,580,950.00	12,050,466.00
Transit to Mexico	949,070.00	.....	2,210,581.00
Transported to interior ports	811,427.00	.....	1,333,161.00
Specie	589,344.00	585,792.00	655,816.00
Total	14,151,511.00	10,695,318.00	22,011,338.00
Total duties collected	2,200,275.44	2,682,385.12	6,878,271.76

APPENDIX 5 C.

List of civilian engineers, employed on works of river and harbor improvement, fourth district, improving Mississippi River, from May 1, 1899, to May 1, 1900, in charge of Maj. George McC. Derby, Corps of Engineers.

Name and residence.	Time employed.	Compensation per month.	Where employed.	Works on which employed.
	Months.			
H. S. Douglas, New Orleans, La.	12	$225	Natchez, Miss., and New Orleans, La.	Improving harbors at Natchez, Miss., and Vidalia, La.; improving Kempe Bend, Louisiana, and improving harbor at New Orleans, La.
W. J. Hardee, New Orleans, La.	12	225	New Orleans, La	Levees: Lower Tensas, Atchafalaya, Lafourche, Barataria, Pontchartrain, and Lake Borgne Levee districts.
A. F. Woolley, Jr., New Orleans, La.	12	150	.....do	Improving Atchafalaya and Red Rivers, Louisiana, and improving Kempe Bend, Louisiana.
E. B. Geddes, Natchez, Miss.	12	150	Natchez, Miss	Improving harbors at Natchez, Miss., and Vidalia, La., and improving Kempe Bend, Lousiana.

APPENDIX 5 D.

REPORT OF MR. H. S. DOUGLAS, ASSISTANT ENGINEER.

NEW ORLEANS, LA., *May 1, 1900.*

SIR: I have the honor to submit the following reports on the works under my supervision for the period ending May 1, 1900:

KEMPE BEND.

The Kempe Bend has been famous, or rather notorious, in levee annals for the past thirty years for persistent caving of the river bank, entailing the building of costly new levees to replace those that were destroyed by the rapid recession of the shore or bank line. It is estimated that not less than $1,250,000 has been expended for levees in the bend since 1868.

In August of 1898 it was reported that the then existing levee, which had been constructed by the United States, was threatened by the caving of the river bank. I

was directed to make an inspection, and found the conditions to be as bad as reported. A short piece of new levee, commonly designated as a run-around, was projected to cover the prospective gap, and its construction was undertaken. Ultimately this run-around had to be extended farther downstream to cover other threatened portions of the levee, and from various unavoidable causes its construction was attended with unusual difficulty and expense. Of course the building of this comparatively short piece of new levee merely postponed the evil day, and it soon became evident from the continued caving of the river bank that a long line of entirely new levee would shortly be required in the Kempe Bend. Owing to peculiar local topography a levee located on any line that offered reasonable permanency would cost at least half a million dollars to build, and it was considered highly improbable that it could be constructed in any one low-water season. This meant a crevasse and probably an overflow during at least one high-water or flood period in the river.

It was obvious that any reasonable expenditure that would preserve the existing levee was more than justifiable. At their meeting in March, 1899, the Mississippi River Commission made an allotment of $180,000 to be expended for the continuous revetment of that portion of the Kempe Bend where the levee was most immediately threatened. The foregoing introduction has been written because this is a new work and its origin and object should be explained.

At the time the allotment was made the river was too high for bank protection work; some new plant had to be acquired and material purchased. In the report on Giles Bend it is stated that a portion of the plant was moved to Bondurant Island, and the construction of willow mattresses commenced August 6. As these mattresses were intended for both the Kempe and Giles bends, the date of commencement for the one is the same as for the other. The general type and methods of mattress construction were the same as described in previous reports on other works in the district, and such details as are considered necessary have been given in the annual report on work done in Giles Bend.

The actual work of placing bank revetment in the Kempe Bend did not commence until September 21, 1899, the cause of the delay being lack of steam power to handle the plant and mattresses in the swift current of the Kempe Bend. On September 21 the quarter boat *Gamma* arrived in the Kempe Bend. The condition of affairs on that date was very discouraging—almost hopeless. At one place but 140 feet of the foreshore remained between the levee and the river, and the bank was caving so rapidly and continuously that it was almost impossible to find a safe place to moor the quarter boat anywhere within a mile of the proposed work.

On September 23 an attempt was made to place the first section of mattress with two tugs, the *Baton Rouge Belle* and the *General Comstock*. It resulted in failure, as the two tugs, even with the assistance of three 5-inch lines run out from the mooring barge, were unable to hold the mattress in the rapid current. The situation was unusually serious, and I telegraphed you to come.

Another attempt to place a mattress was made on September 26, with three tugs, the *Comstock* and *Belle* being reenforced by the powerful new tug *General A. A. Humphreys*. This attempt was successful, but in the interval the bank had caved until but 113 feet remained between the levee and the river.

Meanwhile a careful hydrographic survey which had been in progress developed the fact that the depth of water in the channel of Kempe Bend was very much less than had been supposed, averaging only about 40 feet, the maximum depth being generally within 150 feet of the low-water shore line.

A consultation was held and it was decided to limit for the present the width of the subaqueous mattress to 200 feet. The reasons for this were: First, a mattress of this width not only reached the line of deepest water in the channel, but passed over it to the commencement of the rise to the opposite bank; second, even should a scour occur necessitating that the mattress work should be widened, such additional mattress work could better be placed after the formation of the new subaqueous bank than before.

Accordingly on this basis the sinking of mattresses was continued under unusual difficulties, but with a fair degree of success, until November 9, when 2,961 linear feet of bank covering the most immediately threatened points had been covered. On October 5, after a mattress had been ballasted and was in process of being sunk, the mooring lines, that were supposed to stand a strain of 90 tons, parted, and the mat drifted out of position before landing on the bottom. However discouraging this mishap was, it bore testimony to the exceeding strength of the mattress itself. It is surprising that the cables parted before the mattress was wrecked by the toggle lines cutting their way through the head block. This mattress and one other, lost by by being left in the Bondurant chute by the rapidly falling river, were all that were lost out of the 51 acres built, being less than 2 per cent, which I consider very small on work of this character.

The project for the Kempe Bend revetment contemplated the grading of the bank above the low-water line to a slope of about 1 in 3 and the paving of the same. Owing to limited time it was impossible to construct a hydraulic grader, and one was borrowed from the Third Mississippi River district.

As early as August 18 the tug *Tilda* proceeded to Lake Providence and brought down *Hydraulic Grader No. 3*. For reasons heretofore given it was not until October 8 that the grader commenced work on the bank in Kempe Bend, and continued, with few interruptions, until February 8, 1900, when she had graded 3,587 linear feet of bank. Only a single crew was operated, and the entire work of the grader was exceedingly satisfactory, with the one exception that the grade obtained was generally much flatter than 1 in 3—sometimes as flat as 1 in 5. This fault is, however, common to all machines of this kind working in light, sandy material. When the bank is of clay almost any desired slope can be obtained, even as steep as 1 in 2.

Some grading by the sluicing process was done, but under very unfavorable conditions, and only about 300 linear feet of bank was graded in this way. Without entering into any discussion as to the comparative cost of the two methods of grading, it may be said that so long as the factor of limited time enters into the problem of bank protection, some more rapid means than grading by hand is essential. Up to the present time the hydraulic grader is the best machine that has been devised to meet the conditions.

Upper bank paving was commenced on November 11, 1899, and, except when short of material, or when the force were engaged in ballasting and sinking mattresses, was prosecuted continuously until February 25, 1900, by which time the river had risen to such a height that further paving was impracticable. During this time over 5¼ acres, or 230,500 square feet, of upper bank were paved with five different kinds of pavement, described as follows:

First. Rock placed by hand in the usual way, with the voids filled with spalls, and averaging 10 inches in thickness.

Second. Concrete blocks averaging 8 inches in thickness. These blocks were manufactured on the gravel bar at the head of Bondurant Island, and their manufacture is described in the report of Mr. A. F. Woolley, jr., assistant engineer.

Third. Run of the kiln brick laid as follows: The area to be paved was divided into squares measuring 10 feet on a side by strips of 2 by 4 inch lumber laid on the flat. These squares were then filled in with brick laid on the flat and with their greatest length parallel to the bank line, care being taken to break joints with adjoining streaks. The bricks were laid in loose, a space of about one-half inch being left around each brick. Over this first layer of brick No. 10 galvanized wire was then stretched in such a way as to obtain a mesh 6 by 12 inches, the 12-inch dimension being measured parallel to the bank line. The wire was held in place by staples driven in the 2 by 4 inch strips, and it was so arranged that those wires that were parallel to the bank line should not be in lengths of over 50 feet, and that each 50 feet of pavement, measured parallel to the bank line, should not have continuous wires with the adjoining 50 feet. A cement mortar made of one part Portland cement to three parts of selected Mississippi River bar sand was then mixed, and with it a second layer of brick, each brick being precisely over each brick in the first layer, laid with the wire mesh in between. The joint made of the cement mortar was about three-eighths of an inch thick.

Fourth. Concrete in situ. The area to be paved was first divided off into squares measuring 5 feet on a side by strips of 2 by 4 inch lumber laid on the flat. The wire mesh was then constructed the same as for the brick. A second strip of 2 by 4 inches was then laid on top of the first. It will be seen that squares or molds 4 inches deep, with the wire mesh halfway between the bottom and top, were thus made. The squares were then filled with a hand-mixed concrete made of one part of Portland cement to twelve parts run-of-the-bar sand and gravel obtained from the gravel bar at the head of Kempe Chute.

Fifth. Concrete in situ the same as No. 4, laid without either the timber strips or wire, but 8 inches thick instead of 4. Only a small area was paved in this way as an experiment.

The general scheme of upper bank pavement, which was adhered to as closely as circumstances permitted, was to divide the graded bank into three strips of nearly equal width from low-water mark to a height 18 feet below the high water of 1897, except where the top of the natural bank was below this grade. The lower strip was paved with either rock or concrete blocks. The middle strip laid with brick as described or with concrete blocks. The upper strip with concrete in situ 4 inches thick, in squares with wire mesh as described.

From November 9, 1899, until February 10, 1900, owing to limited plant, it was not practicable to sink mattresses in the Kempe Bend. On the latter date sinking was

resumed and continued until March 10, 1900, when all work was suspended on account of the high stage of the river, which read 28.2 and rising on the gauge at Vicksburg.

In order to avoid a weak point in the general revetment great care was taken in making the junction between the main mattress work and the upper bank pavement. Where the subaqueous mattress did not extend to the dry bank at the then existing stage of the river, either special mattresses were built to fit in the concave pockets or small mattresses, described for convenience on the work as ribbon mattresses, were built and sunk with their outer edge lapping on the main mattress, while their shore edge was on the dry bank, and from it the upper bank pavement was commenced. By this means there was a reasonable certainty that no uncovered bank remained between the subaqueous work and upper revetment.

Toward the end of the season's work, when the river had risen to within a few feet of the top of the bank and it was impracticable to either grade or pave, the ribbon mats were used exclusively to join the dry bank to the main mattress work. This and the fact that 656 linear feet of the bank at the upper end of the revetment work were graded, but not mattressed or paved, will explain the difference between the length of bank protected and that graded and paved.

The total length of the working season in the Kempe Bend was one hundred and seventy-four days, during which the following was accomplished:

Linear feet of bank protected	4,008
Square feet of mattress sunk	1,034,459
Square feet of bank graded and paved	230,500

The total field cost of the season's work was $110,782.49, divided as follows:

Construction of mattresses	$40,819.75
Towing of mattresses	1,371.19
Sinking of mattresses	34,147.76
Grading upper bank	7,556.75
Paving upper bank	24,992.12
Installation, etc	1,894.92
Total	110,782.49

Using the linear foot of bank protected as the unit of field cost, I find this to be $27.64.

As the mattress work did not differ materially from that of previous years at other localities, no particular analysis of it is necessary. The contrary, however, is the case with the upper-bank revetment, as it was not only a novel work in the Fourth district, but there were a great many kinds of pavement used, as heretofore described. The areas paved with the different kinds were as follows:

	Square feet.
Rock, 10 inches thick	45,027
Concrete blocks, 8 inches thick	55,658
Brick as described	45,700
Concrete in situ, 4 inches thick	75,375
Concrete in situ, 8 inches thick	8,740

For comparative purposes I have compiled from data kept in the field the following as the cost per square foot of the different kinds of pavement:

Rock, 10 inches thick	$0.1392
Concrete blocks, 8 inches thick	.1544
Brick as described	.1165
Concrete in situ, 4 inches thick	.05394
Concrete in situ, 8 inches thick	.0849

A careful survey of the bend was made during the summer and fall, and the necessary permanent points for locating work and for future comparative surveys established. In addition to this constant topographical and hydrographic work was necessary during the progress of the work to properly locate and place upper-bank pavement and the subaqueous matresses; also, to detect any scour in the river bed beyond the mattress work. No scour occurred until near the close of the season's work, when soundings showed a deepening of as much as 10 feet in places along the bottom just beyond the outer edge of the mattress work.

An inspection of the work was made on April 30, 1900, and on that date the work appeared to be in good condition, and from the standpoint of preventing further caving of the bank and the consequent loss of the existing levee was accomplishing the object for which it was designed.

GILES BEND.

At the close of last report sixteen spur dikes containing 804,900 square feet of mattress and 868,800 cubic feet of cribs had been placed in Giles Bend. Extensive scouring had occurred between the spurs, and the bank between had caved until nearly all of them were on salient points. In some cases the caving threatened to flank the spurs and their connection with the high-water bank had been partly destroyed. The unprotected bank at the lower end of Giles Bend had caved until the spur levee on Cowpen Neck near its outer end was threatened for a length of 3,000 feet. A considerable amount of material was either on hand or under contract for early delivery. The plant was in lying-up quarters at the head of Giles Bend.

The approved project for the season's work contemplated a careful survey to ascertain the existing conditions before commencing work; the repair of the spur dikes where their shore connection was partly destroyed; the continuous mattressing of the subaqueous bank from Spur 3 to 15, and the paving of the upper bank at such places as the action of the water had naturally graded the bank to a sufficiently flat slope for the purpose.

Operations were commenced on July 27, when the quarterboat *Delta* was put in commission, and in tow of the tug *Tilda* left Giles Bend for Bondurant Island, the locality that had been selected for the construction of the necessary willow mattresses. The quarterboat arrived there July 28, and the building of ways and cutting of willow brush at once undertaken. Construction of mattresses was commenced August 6, which is the earliest date that work of this kind has been undertaken in Fourth district. However, the river was unusually low for the season, being but 18.2 on the gauge at Vicksburg.

As all the mattress work for both Kempe and Giles Bend was built by the same force and at the same localities, it was practically one job, and the details will be given in this report and omitted in that on the Kempe Bend.

Construction of willow mattresses commenced at Bondurant Island August 6, 1899, and continued to March 9, 1900, a period of 225 days, during which time 2,234,224 square feet, or 51.3 acres, were built. On account of the large quantity of willows used—approximately 23,512 cords—it was necessary to move from Bondurant Island to the Willow Bar above Bruinsberg Landing, and after exhausting the willows at this second locality, to move a third time to the Kempe Island. In all an area of 426.6 acres was cut over to obtain the quantity of brush required.

On August 4 the quarter boat *Gamma*, lying at the Government depot in New Orleans, was put in commission and left in tow of the tug *General A. A. Humphreys* (a new tug just purchased and more particularly described in report on plant) for Giles Bend, where she arrived on August 10. The major portion of the force on her was transferred to the quarter boat *New Orleans*, then lying up in Giles Bend. The *Gamma*, with the remainder of her force, was left in Giles Bend to load rock from the supply on the bank, while the *New Orleans*, with the transferred force, was towed to Bondurant Island. On her arrival there on August 11 her force was added to that already on the ground from the *Delta*, and the construction of mattresses pushed. Ultimately, when the quarter boat *New Orleans* was required elsewhere, a camp was established on the bank. This method of quartering and subsisting the men was fairly satisfactory, and possesses the conspicuous advantage of reducing the amount of floating plant, thus enabling a much larger amount of work to be done with a limited plant than would otherwise be possible.

The force in Giles Bend on the *Gamma* meanwhile continued loading rock on barges and generally getting the plant in readiness to sink mattresses. It was not intended to sink the first mattress in Giles Bend, but in Kempe Bend, where a serious emergency existed. However, owing to a series of unavoidable delays the stern-wheel steamer *General John Newton* and the tug *General Comstock*, belonging to the district, were detained in New Orleans long beyond the time when it was expected that they would arrive on the ground. The Kempe Bend is one of the few localities on the river where the current is more rapid during low water than it is at high, and with the small amount of steam power at my command it was impracticable to undertake work at that locality. Some of the mattresses, however, commenced to silt up, and it was necessary that they should be sunk at once. Accordingly, the plant was placed in position in Giles Bend on August 25, and the first mattress sunk on August 30, immediately above Spur No. 15. On September 5 the steam plant was reenforced by the arrival of the chartered tug *Baton Rouge Belle*, and on September 8 the U. S. tug *General Comstock* arrived. It was then decided to temporarily suspend sinking in Giles Bend and move to Kempe, where an inspection showed the situation to be very critical. On September 15, after sinking 283,210 square feet of mattress and completing the subaqueous work from Spur 12 to Spur 15, the plant was moved to Kempe.

It was not until October 10 that sufficient plant could be spared to resume work in Giles Bend. On that date the quarter boat *New Orleans* was taken off mattress construction and brought to Giles Bend. The force at once commenced loading rock on barges preparatory to sinking mattresses, paving bank, etc. On October 17 sinking of mattresses was resumed, and on October 20 grading and paving of the upper bank was commenced. A large amount of grading was done by laborers with shovels, as it was decided to pave the upper bank, where practicable, to a height about 10 feet above average low-water mark. This was done to assure the making of a proper junction from which to continue the paving up the bank the following season, even if the river did not reach a very low stage, as in 1898.

On October 18 the steamer *General John Newton* arrived in Giles Bend with the first tow of brick from Baton Rouge, and from this time on to January 18, 1900, she was engaged in the long-distance towing of cement from New Orleans and brick from Baton Rouge. In ballasting mattresses both rock and brick were used, and in the upper bank paving rock, brick, and a small quantity of concrete blocks were used. Some of the brick pavement was similar to that laid on a larger scale at Kempe. For the sake of experiment the upper layer of brick was omitted on a small area and the wires fastened to the lower layer of bricks with cement mortar alone.

There has been no change in the character of mattresses used, except to make them somewhat more dense. One of the claimed advantages for the framed mattress received a practical test in the Giles Bend work of the past season. On account of the caving between the spurs there was no such thing as even an approximately smooth shore line, but a series of deep bays with irregular shaped points projecting at intervals. A careful traverse was made of this shore line, the necessary designs made and sent to the willow bar where the mattresses were built in accordance with the plans. Afterwards they were towed to the particular locality for which they were intended and with scarcely an exception they fitted perfectly. This could not have been done with the fascine or woven mattress.

The work was hampered to some extent by the slow arrival of brick, and by the prevalence of smallpox at the place where the mattresses were being constructed. However, on January 30, 1900, the river having risen to 19.2 on the gauge at Vicksburg, and no further work under the project being practicable at that time, operations were suspended and the plant moved to Kempe Bend.

The total working time in Giles Bend was one hundred and forty-four days, and during that time 1,189,765 square feet of mattress were sunk and 144,000 square feet of upper bank graded by hand and paved. The new work extends from the upper edge of Spur No. 3 to a point 250 feet below Spur No. 15, a distance by the bank line of 6,345 linear feet, of which 2,200 linear feet was repair work to existing spur dikes. With the exception of Spur 8½, every spur from No. 3 to 15 had additional mattress work added to its shore end, and the upper bank paving was renewed. Owing to the similarity of the work and the fact that it was all in progress at the same time, it was not practicable to separate the cost of repairs to the old spur dikes from the new continuous mattress work with any degree of exactness.

The total field cost of the work in Giles Bend was $92,934.65. I assume that the cost of repair work to existing spurs was $15,547.50. This is not absolutely accurate, but is a fair approximate. Deducting this from the total cost leaves $77,387.15 as the cost of the absolutely new bank protection work, being $18.67 per linear foot. This may be subdivided as follows:

Subaqueous work, per linear foot	$16.31
Upper-bank work, per linear foot	2.36

It has been mentioned previously that the upper-bank pavement has not yet been carried to its ultimate height, but to a line about 10 feet above average low-water mark.

The detailed field cost of the season's work is given below:

Constructing mattresses at Willow Bar	$42,974.31
Towing mattresses to Giles Bend	1,530.32
Sinking mattresses in Giles Bend	29,631.00
Grading and paving upper bank	16,884.10
Installation, etc	1,894.92
Total	92,934.65

From the data at hand the following units of field cost per square foot of mattress are obtained:

Construction	$0.03946
Towing	.00127
Sinking	.02492
Cost per square foot in place	.06565

Until within the past year bank protection work in this district has been confined principally to spur dikes, and the cost per square foot of mattress and per cubic foot of crib work was the most convenient and useful unit. Recently, with the placing of continuous revetment and upper-bank pavement, I think that this unit should be changed and the linear foot of bank protected be used. Accordingly, I have compiled the following as the cost per linear foot of protected bank:

Construction of willow mattresses	$9.25
Towing of willow mattresses	.335
Sinking of willow mattresses	6.45
Grading and paving upper bank	2.24
Installation, etc	.394
Total cost per linear foot	18.669

This unit does not include the cost of what may be termed repair work to existing spurs, and of course is not for completed upper-bank pavement.

A careful and thorough hydrographic survey of Giles Bend has been made and data obtained from which even an insignificant change from existing conditions can be detected. So far as an ocular inspection can determine, the work of the past season has been successful. Caving over the unprotected portion of the bend does not appear to have been as active as in past years, and the spur levee on Cowpen Neck is, as yet, intact, although there is a reasonable certainty that it will be breached by caving banks before next high water.

PLANT.

At date of last report the plant consisted of 39 pieces. During the year the hydraulic dredge *The Ram* and one small lighter have been transferred from my charge. Barges Nos. 16 and 28, transferred to the Quartermaster's Department and lost on their way to Cuba, have been replaced by two new barges. The stern-wheel steamer *General John Newton*, built under contract with the Iowa Iron Works, has been received and a large tug, the *General A. A. Humphreys*, purchased.

The plant now on hand consists of the steel hull stern-wheel steamer *General John Newton*, the steel hull tug *General A. A. Humphreys*, wooden hull tugs *General Comstock* and *Tilda*, and the small wooden hull stern-wheel steamer or launch *Ruby;* the quarterboats *Alpha*, *Beta*, *Delta*, *Gamma*, and *New Orleans;* standard barges Nos. 1 to 10 and Nos. 15 to 28, barges Nos. 550 and B, a floating warehouse, a dock, pile driver No. 32, a pump boat, and one small lighter—41 pieces in all, not including two camel docks, side docks, pontoon, skiffs, etc. Owing to the plant being in active service in the field for nearly the entire year, operations at the depot have been limited, not because extensive repairs were not required, but because there was no time to make them.

NEW PLANT.

Barges Nos. 16 and 28 have been replaced by two new barges built under contract. They are gunwale barges of the standard size, 124 feet long, 30 feet wide, and 7 feet 7 inches deep at the gunwales. The specifications under which they were built were carefully drawn and their construction was superintended by a competent inspector. As a result these barges are probably the best of their kind on the Mississippi River, being built of choice clear Louisiana cypress.

When the steamer *Osceola* was condemned as being beyond economical repair, the district was left without a large stern-wheel steamer suited for inspection purposes and towing. Under contract with the Iowa Iron Works a steel-hull stern-wheel steamer, which has been named the *General John Newton*, was built, delivered in New Orleans, and after several trial trips accepted. The following is a general description of the boat: Hull of steel, 150 feet long, 23 feet wide, and 7 feet 9 inches deep. Engines, cross compound surface condensing; high-pressure cylinder 14 inches diameter by 6-foot stroke; low-pressure cylinder, 36 inches diameter by 6-foot stroke. Boiler, internal fired of the Hopkins type. The boat has not been generally satisfactory from the standpoint of towing, principally on account of numerous breakdowns. With the alterations and improvements that have been made it is now thought that she will be able to give good service.

With the extension of bank protection work in the Fourth district it became evident that the existing plant was not equal to the demands made on it, and it was especially weak in the matter of steam power. The purchase of an additional and larger tug was authorized, and after due advertisement I was directed to inspect the several boats offered for sale. After careful examination I recommended the purchase of the tug *Isabella T. Dempsey*, then lying at Baltimore, Md. My recommendation being approved, the purchase was made and arrangements made with the

owners to deliver the boat in New Orleans. She made the sea trip without accident and arrived at the Government depot, New Orleans, July 23, 1899. The following is a general description of the new tug, which has been named the *General A. A. Humphreys:* Hull of steel; length over all, 90 feet; beam unloaded, 19 feet; depth unloaded, 10½ feet; 4 water-tight compartments; coal capacity, 500 barrels. Engines, steeple compound surface condensing, size 13½ and 24 inches by 20-inch stroke. Boiler, Scotch marine, 10 feet diameter, 11 feet long; thickness of shell, 0.765 inch; two corrugated furnaces and one hundred and twenty-eight 3¼-inch tubes; allowed pressure, 150 pounds. The age of the boat at the time of purchase was 14 months. The *Humphreys* was at once put in commission and commenced towing the plant from New Orleans to Giles and Kempe bends. With the exception of two breakdowns, the boat was in constant service from July 23, 1899, until January 17, 1900, and rendered valuable and satisfactory service. On this last date she lost her propeller and, pending repairs, was returned to the depot and put out of commission.

In the construction of the two new barges, Nos. 16 and 28, great difficulty had been experienced in obtaining satisfactory timber of the large dimensions required, clear of sap. As the construction of six new barges was authorized the specifications were amended and provisions made for using creosoted timber in those portions of the barges most liable to decay. This permitted the use of sap and lessened the difficulty of obtaining pieces of the required dimensions. A contract for the construction of the six new barges was let on June 30, 1899, and work on them is now fairly well advanced.

REPAIRS.

Tug General Comstock.—Practically rebuilt. Entire new frames of cypress treated with carbolineum avenarius from forward end of boiler to stern; new deadwood from keel up; new keelson, 35 feet long, treated with carbolineum; entire new set of top timbers from forward end of boiler to stern, of cypress, treated with 21 pounds of creosote to the cubic foot by the vacuum and pressure process; new fantail, new rider, new transom, all treated with carbolineum; entire hull, except four strakes on the bottom, replanked with cypress planking; inside of hull sheathed, cabin straightened up and braced, scraped, painted, and varnished. After being calked all seams in hull were puttied, which was then given two coats of coal tar to water line and painted above; the machinery generally repaired; a new solid forged crankshaft was installed; also a new tail shaft and new propeller; thrust bearings fitted with two new thrust rings. New brass bushing and bottom ring for the tail shaft stuffing box; new cast-iron bushing for stern bearing; main cylinder rebored, main valve planed and seat faced; new follower and packing rings fitted to piston; piston rod shortened and new connection rod made; new crosshead guides, new balanced pinch wheel, and eccentrics turned up and fitted to straps. Link motion and link block repaired; steam cylinder of boiler feed pump rebored, piston fitted to same; new piston rod made and fitted, steam valves faced, and new liner fitted in water cylinder. The boiler head and entire new furnace side and bridge walls of the best quality of fire brick laid in fire clay, and new door and fire liners were placed. Total cost, $3,827.99.

Tug Tilda.—Thirteen new plank of various lengths were put in on sides and bottom of hull, besides numerous graving pieces. New fender strake, plank shear, and covering board put in in places and chocks repaired. One piece of keelson 22 feet long and seven new floor timbers were put in. Hull calked, coal tarred, and painted. Pilot wheel repaired and pilot house generally overhauled and refitted. New roof on cabin. A new end was welded on the tail shaft, which was fitted with a new coupling and stern bushing. Steam cylinder of feed pump rebored and valves fitted and seats faced. Slight repairs to boiler. New furnace side, bridge and back walls built, this work being made necessary by having to remove the boiler to put in new keelson. Cost, $638.40.

Steamer General John Newton.—Repairs to boiler, engines, and shaft. No detailed account can be given, as the majority of the repairs were made during my absence from the depot. The following may, however, be mentioned: New wooden pitmans, new crosshead, new end welded on shaft, new pillow block complete, new wheel, new cam-yoke guides, installation of safety valves in receiver and on low-pressure cylinder, rudder bumpers, etc. Approximate cost, $1,144.41.

Steamer Ruby.—One new half-eccentric strap and one sectional eccentric; cost, $15.

Pile Driver No. 32.—Two new tubes in boiler; cost, $10.95.

Small lighter.—Practically rebuilt at a cost of $208.86.

Quarter boat Beta.—Entire new floor timbers, bottom, and rakes. Two new gunwale timbers put in, one on each side. Floor timbers and bottom gunwales treated with carbolineum. Bottom and sides calked and given two coats of coal tar. Cost, $450.68.

Barges Nos. 18 and 24.—Cargo boxes were built on these barges for the storage and transportation of cement; cost, $439.71.

CURRENT REPAIRS.

These comprise the miscellaneous odd jobs, difficult to specify but necessary to maintaining the plant, such as new cavils, iron bitts to replace rotten wooden ones, work on doors and windows of boats, in boxes, stove pipes, skiffs, etc., etc.; cost, $438.38.

CARE OF PLANT.

As the plant has been in active service nearly the entire year, the cost for supervision at depot, watching, cleaning out barges, shifting lines, spars, etc., has been unusually small, being only $2,276.04.

CONDITION OF PLANT.

At the moment of writing extensive repairs to the entire plant are either under way or contemplated. From this it may be understood that the general condition of the plant is bad. It is not necessary to go into details, but the general statement can be made that there is not a skiff, barge, quarter boat, tug, or steamer that does not require work more or less extensive.

Very respectfully, your obedient servant,

H. S. DOUGLAS, *Assistant Engineer.*

Maj. GEO. McC. DERBY,
Corps of Engineers, U. S. A.

APPENDIX 5 E.

REPORT OF MR. A. F. WOOLLEY, JR., ASSISTANT ENGINEER, ON IMPROVEMENT OF ATCHAFALAYA AND RED RIVERS, LOUISIANA.

JUNE 1, 1900.

SIR: I have the honor to submit the following report of operations for the work of improving Red and Atchafalaya rivers during the year ending May 31, 1900.

DREDGING.

Old River.—The dredge *Ram* was placed in readiness and took the field on July 22, 1899. Dredging was commenced July 29 and carried on during intermittent periods as conditions required until November 28, when the stage of the river made it unnecessary for further dredging, and the dredge was ordered to New Orleans to be laid up and repaired.

Navigation was maintained throughout the season, a clear channel of 6 to 9 feet or more prevailing during the low-water period, except for short intervals of two to three days, when there was not more than 5½ feet over the shoal places immediately in front of the dredge.

Red River above Turnbull Island.—This stretch heretofore was not under the jurisdiction of the improvement of the Red and Atchafalaya rivers.

The president of the Mississippi River Commission ordered the *Ram* to devote such time as was not necessary to maintain navigation in Old River to removing any obstruction to navigation in Lower Old River.

After Old River was placed in good condition the obstruction in Lower Red River was not of such magnitude as to warrant the risk incidental to carrying the dredge, with its badly decayed hull, over the Red River Dam.

Fords Crossing and other bars below Vicksburg, Miss.—As these bars are also out of the regular jurisdiction of the Fourth district, the president of the Mississippi River Commission directed that the dredge *Ram* be utilized to keep open to navigation any bars below Vicksburg, Miss., when not necessarily engaged elsewhere. None of these bars, however, became so shoal as to require dredging.

Dredging operations in Old River were confined to Carrs Point Bar at the mouth, Dead Tree to Ash Cabin, and Chandlers to head of the Atchafalaya.

The bar across the mouth.—Carrs Point was somewhat higher and necessitated the removal of greater yardage than during the past few seasons. The stretch known as

second crossing has ceased to shoal, and has shown a depth of 11 to 15 feet during the past two seasons.

In the stretch known as Dead Tree to Ash Cabin much the same conditions prevailed as for the two previous seasons.

The reach between Chandlers and the head of the Atchafalaya showed more shoaling than during the past two seasons.

The actual dredging required at the several localities were: Carrs Point, 73,200 cubic yards; Dead Tree to Ash Cabin, 19,200 cubic yards; and Chandlers to the head of the Atchafalaya, 16,500 cubic yards.

Taken as a whole, the general condition of Old River was much the same as it has been during the past two years, though the special features as to direction and velocity of current required rather more than the usual amount of dredging.

The caving at the mouth along the Torras front has been much less than for the two previous seasons. The sloughing banks along Old River were in evidence as usual, but are gradually improving with the annual dredging of lakes and pools in the immediate vicinity. The lakes were drained by contract at a cost of $150.

The average cost of dredging, including all the expenses incurred during the days that the dredge was in operation, was $0.0304 per cubic yard. The total cost of maintaining navigation, including care and repair of dredge and salary of master and watchman for the year, was $7,826.49.

Here I would like to make special mention of the very satisfactory manner in which the master of the *Ram*, Mr. R. H. Bolen, performed the duty of inspector on the construction of the new steel hull. I wish further to make special mention of the energy and skill displayed by cranesman, Mr. C. N. Vosburgh, while acting as master of the dredge *Ram* during the absence of Mr. Bolen as inspector on construction of the new steel hull.

Atchafalaya sill dams.—The usual annual survey was made to determine the condition of the sill dams and vicinity to show the location and extent of such work as may be necessary to protect these structures as well as the additional ones originally contemplated in the project of the Commission.

As to the result of this survey I will only say that the conditions still point to the advisability of additional work at this locality, the details having been reported upon by Mr. H. S. Douglas, assistant engineer, who has been charged with the execution of the work.

PLANT.

A steel hull, cutter frame, cylinder beams, ballast tanks, engine and pump foundations have been built for the dredge and delivered at New Orleans, La., by the Springfield Boiler and Manufacturing Company, of Springfield, Ills., for the contract price of $14,650.

The new hull is of 3 feet greater beam, 25 feet greater length, and 1 foot greater depth than the old wooden hull.

The transfer of machinery and the building of a cabin is being done at the Government depot at New Orleans, and it is expected to have the dredge ready about the 1st of July, should it be necessary to take the field so soon. Dredging operations have rarely been necessary earlier than the 1st of August.

SURVEYS, GAUGES, AND OBSERVATIONS.

Surveys have been made at the following localities in New Orleans Harbor: Southport, Carrollton Bend, Greenville Bend, Gouldsboro Bend to Algiers Point and Third District Reach.

These surveys were executed by the use of a plane table and a sounding reel, the lead line being of piano wire about one twenty-fifth of an inch in diameter, the reel reading to one-tenth of a foot.

The soundings were located on the plane-table sheets as they were taken, the direction being determined by the alidade and the distance by piano wire attached to a peg under the plane table and to an additional reel in the boat with the sounding reel.

The boat was drifted from the upstream side to the downstream side of an area corresponding to the plane-table sheet and on arcs corresponding to arcs previously drawn on the plane-table sheets, the distance wire serving as a radius on which the boat was swung, the oars being so maneuvered as to keep the distance wire taut.

By this method the entire area between the water's edge and the desired distance out into the channel was thoroughly studded with soundings and it was impossible to leave any unsounded gaps without the plane-table sheets showing such discrepancies before the party left the field.

Some of these surveys were duplicated and comparisons were much more satisfactory than the surveys by the old methods in vogue heretofore.

Very respectfully, your obedient servant,

A. F. WOOLLEY, JR., *Assistant Engineer.*

Maj. GEO. McC. DERBY,
Corps of Engineers, U. S. A.

APPENDIX 5 F.

REPORT OF MR. A. F. WOOLLEY, JR., ASSISTANT ENGINEER, ON CONCRETE BALLAST.

NEW ORLEANS, LA., *March 30, 1900.*

SIR: I have the honor to submit the following report on the result of the season's work of making concrete as a substitute for natural rock for ballasting mattresses and paving subaqueous slope in connection with bank-revetment work at Kempe and Giles bends, Louisiana and Mississippi.

Pursuant to your instructions to conduct certain experiments looking to the utilization of the sand and gravel deposits as a substitute for natural rock in connection with bank revetment, I made a number of experiments last summer.

The time available for the experiments was somewhat limited, but without going into detail as regards the experiments themselves, it was determined that a concrete of one part Portland cement and twelve parts sand and gravel, in just the proportion they are found on the bar, would answer every purpose, and that the proportion could be increased where the sand bars carried a high percentage of gravel. When the experiments were concluded the time at which it was expected to commence operations was so near at hand that it was a question of much doubt whether a concrete mixer of the type desired could be had from any of the builders without delaying the beginning of the work. From sketches and data furnished by myself to one of the local machine shops, a mixer was built, of the type in most general use, and at a cost of several hundred dollars less than regular builders' price. The plant was all in readiness to go to the field of operations on August 6, 1899, but owing to accidents to some of the towboats, to shortness of plant, to my being ordered away on other work, to necessity for repairs to the tug *Comstock* and towboat *General John Newton*, and to my own illness, the work was not really started until October 11, 1899.

At the particular stage of water when work was commenced, it was decided that Bondurant Island would be preferable to Kempe Towhead as a location for the manufacture of the concrete, as there were two forces carrying on mattress construction in the immediate vicinity, and the tugboats used as tenders at the mattress ways could be utilized when necessary, thus avoiding the expense of an exclusive towboat for the use of the concrete plant. In addition to the foregoing causes for delay, there was a leaky boiler, which would not make steam for the mixing engine. I had been informed, upon inquiry upon the subject, that this boiler was in good condition. The boiler was placed in good condition by having an entire new set of 57 flues put in.

The method of operation was as follows:

The mixer, engine, and boiler were mounted on two tram-car trucks, these two cars being coupled together. There was another or third car, which was used as a batch or measuring car, and into this car sand and gravel was placed in the quantity necessary for one barrel of cement, at the proportions which were being used.

The concrete was formed or molded into blocks or slabs by parallel lines of 12-inch boards placed on edge and spaced 6 feet apart. These boards carried 1 by 2 by 12 inch vertical cleats on their inner faces, these cleats being spaced about 8 inches center to center, or 6 inches in the clear. These cleats supported and held in place plates of No. 12 iron, 12 inches by 6 feet, flanged on one edge 2 inches, so as to form a 2 by 10 inch angle, the 2-inch leg resting on the side board cleats and the 10-inch leg hanging vertical and forming the division between the adjacent blocks of concrete. These plates were used double; that is, one being suspended on each side of each cleat, thus forming a space of 2 inches between adjacent blocks of concrete.

The side or molding boards were held in place by iron clamps or dogs, 6 feet 4 inches long, terminating in a right angle, and a leg 8 inches long on each end. This 8-inch leg served to hold the boards from springing apart while concrete was being tamped, and also to hold themselves vertical by the weight of the 8-inch legs when the molds were being set up.

It will be seen from the foregoing that the ground formed the bottom of the mold. A light and portable track was laid parallel with this line of molds. The mixer was 12 feet long and was mounted crosswise on the truck so as to deliver well over into the center of the line of molds. The batch or measuring car was filled, the material was then shoveled directly to the mixer, thence delivered by the mixer direct to the center of the molds. There it was well tamped and left undisturbed for at least several hours before the molds were removed. The batch or measuring car was operated in such a way that by the time a batch had been shoveled into the mixer another set of men had filled the car with the necessary sand and gravel; this was leveled off and another barrel of cement spread over it and a fresh batch was ready for the mixer in a very short interval. After passing each batch through the mixer the mixer and batch car were moved ahead just so many mold spaces as one batch would fill, thus limiting the amount of shoveling that would be necessary to thoroughly fill each mold.

In this way the work is continued as far as it is desired to carry the line of molds. In the meantime there is a force behind setting a new line of molds parallel to the previous one and shifting the track to a new position. Then the mixer and batch car are rolled back to the end of the new line of molds as before and the process continued, the limit being the territory covered by good material, or the area, otherwise the yard, over which it is desired to place the finished product.

Molding.—The plan for molding originally contemplated making the blocks of concrete 6 by 12 by 12 inches. This was to be accomplished by placing the 6-foot division plates 12 inches apart, and then subdividing further by using 12 by 12-inch plates placed at right angles between the 6-foot plates and spaced 6 inches apart, thus making 12 blocks between each of the 6-inch steel plates. This was impracticable owing to the additional labor of setting molds, difficulty of holding the small plates in place, difficulty of properly tamping the small blocks and removing the small plates. It was found advisable to place the 6-foot division sheets only 6 inches apart in the clear and to subdivide these 6-inch by 12-inch by 6-foot blocks by breaking with a sledge hammer into as many pieces as desired; this was done and included as a part of the process of loading, two men being able to break 150 to 200 tons per day, at a cost of say $0.016 to $0.02 per ton.

The side molding boards were unclamped at the end of one to two hours. This allowed the division plates to press together slightly, the air to circulate freely in the space between adjacent blocks, thus shortening the period at which the steel plates could be safely removed and reset in a new line of molds. Practically, I had often to remove these steel plates at the end of two hours, owing to the limited number at hand; this is entirely too early and results in considerable breakage of the green or fresh blocks. There should be enough of these plates at hand so that they would not have to be removed sooner than six or eight hours. Such a number was not procured this season because of the fact that there was a probability that after a season's work it would be demonstrated that a modification of the plant would be not only advisable but imperative from the point of view of greater economy of operation.

These remarks as to steel plates are also applicable to certain other portions of the plant.

With the facts before me now I am of the opinion that the blocks instead of being molded 12 inches deep on edge could be more economically made deeper. This would admit of a greater tonnage being made and stored on a given area, and they could be more economically handled in loading. Just how much deeper these blocks might advantageously be made I am not in a position to say positively at this moment. Fifteen inches to 16 inches is practical, and I am of the opinion that this might be increased to 18 inches; this latter figure being, I believe, near the limit, as the blocks would be liable to topple over while the plates are being removed.

Loading.—The question of loading was one that was attended with many difficulties and drawbacks.

The old cars and tramway, for a number of years stored at Barbres Depot, was used to transport the concrete from the yard to the barge. The barge was moored "end on" to the shore, the truck being run over a trestle onto and down the center of the barge, the material being dumped to either side. The cars were sent aboard the barge by gravity and carried back by mule.

The track was old, in bad shape, and rather light for a gravity road and high speeds. The cars were old, in bad repair, and too small for the extreme haul. The flatness of the bar and rising and falling stages of the river caused serious delays and repetition of trestle building.

This loading question is a serious one in connection with the cost of manufacturing artificial ballast. It is my opinion that this could be met on two different plans.

First.—A strong pile trestle terminating in a loading pier, the barges to be moored alongside of the pier and the ballast dumped down into the barge over a chute or chutes, the cars to be operated with a cable to let them down and haul them back. The trestle could be built on such an incline as to allow the barges to be loaded just as near the yard as the prevailing stage of the river would permit.

Second.—A cableway could be used with automatic dump buckets, etc. As to these there are several types of this method for transporting materials. I have both of the foregoing methods of transportation under consideration and hope to have bids on each shortly.

The small tonnage that will probably be made next season (10,000 tons) would not in itself justify much outlay in the way of plant, but aside from the best outfit for loading I am confident that all the other portion of the plant can be modified and improved to best suit the purpose at a cost that would be no serious tax on the coming season's work.

The scarcity of white labor made it imperative that I should use negro labor, and for this kind of work I think I prefer the negro labor. Until February I was forced to pay 12½ cents per hour, board included, owing to the fact that there was other work in the immediate vicinity where such wages could be had, and my work was the harder of the two. After the first of February I paid only 10 cents per hour, board included—paying off the hands every Saturday night in cash. For another season I feel that I could get any quantity of labor at 10 cents per hour, board included, and pay off Saturday night.

From the foregoing it will be seen that I have been forced to pay 25 per cent more for my labor than was necessary, and the result is shown in the cost of the finished product.

The following is a statement showing the cost of the finished product on the bar, the cement being included at $2.60 per barrel.

Date.	Tons.	Proportion of cement.	Cost of cement per ton.	Concrete per ton.	Total.
October	700	1 to 12	$1.083	$2.418	$1,689.10
November	2,643	1 to 12	1.083	1.601	4,231.44
December	914	1 to 12	1.083	1.647	1,505.36
Do	1,270	1 to 13	.977	1.541	1,957.07
January	2,385	1 to 13	.977	1.562	3,725.37
February	1,869	1 to 13	.977	1.517	2,835.27
March	530	1 to 13	.977	1.552	822.56
Total	10,311				16,766.17
Plant and miscellaneous expenses charged to manufacture: 10,311 tons, at $0.122					1,257.94
Grand total					18,024.11

It will be noted that the prices per ton for the first month (October) is exorbitant. This is due to several causes, among which were: Most of the work was done by hand, owing to the boiler being in bad condition and undergoing repairs; the work was entirely new to all my subordinates and they had to be educated up to a proper conception of the work, some of them not being adaptable. There were many things I had to learn myself. I was ill with chills and fever, being confined to my room much of the time. I was away under orders part of the time, and finally I might add that at the beginning all of my subordinates, laborers included, regarded the whole thing as a fiasco. It was no small job to furnish all the faith for such an undertaking with all the attendant circumstances. A statement will be found below showing the number of tons loaded, together with the cost.

Date.	Tons.	Average per ton.	Cost.
November to March	5,100	$0.5527	$2,838.77
Plant and other miscellaneous expenses charged to loading, 5,100 tons, at $0.122			632.00
Grand total			3,470.97

Résumé for the season.

Manufacture	$18,024.11
Loading	3,470.97
Total	21,495.08

It will be seen from a glance that this item for loading is very high; to me the price is very unsatisfactory and disappointing.

The most diligent effort was maintained to reduce and keep down the cost for loading, and every time I thought I had reached the point within reason something would happen to upset my calculations. Unfortunately it so happened that when I was in a position to load at anything like a reasonable figure the concrete was not needed.

In my computation for the cost of loading I have been very liberal and at a slight sacrifice to the cost of manufacturing the concrete.

I arrived at my figures in the following manner:

The sum of the salaries, plus all other expenses, plant excepted, divided by the number of tons manufactured, plus the number of tons loaded, equaled the average cost for each handling; i. e., manufacturing and loading.

This, as you see, places the cost of loading on a par with the cost for manufacturing, less the value of the cement. In arriving at the cost of manufacture the cement was reckoned at $2.60 per barrel or $1.083 per ton of concrete at the proportion of 1 to 12 and $0.977 per ton of concrete at the proportion of 1 to 13.

General remarks.—It was in my opinion found advisable to use more water than is required theoretically, thus saving some labor in tamping, as the tamping was by hand, the slightly wetter material being so little inferior to that mixed in the correct "damp" state as to more than offset the additional labor of tamping.

As to loading, I think it would be best to have, say, 60 to 75 per cent of the concrete made prior to date of being used; then one force could be utilized to do the loading and also to finish making the balance of 40 to 25 per cent of the concrete at such odd intervals as there would be while no empty barges were available for loading.

Possibly a still better plan would be to have all the concrete made and the making force disbanded, the loading to be done by the forces of the assistant engineer in charge of the bank revetment work. This would place the loading entirely at his convenience, and thus make the loading and the use of the ballast work in perfect harmony.

Very respectfully, your obedient servant,

A. F. WOOLLEY, Jr.,
Assistant Engineer.

Maj. GEO. McC. DERBY,
Corps of Engineers, U. S. A.

APPENDIX 5 G.

UNITED STATES ENGINEER OFFICE.
New Orleans, La., June 30, 1899.

No. 1.—*Abstract of proposals received in response to advertisement (circular) dated May 25, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Evergreen-Bondurant Levee.					
		Lot 1, sections 1–6.	Lot 2, sections 7–12.	Lot 3, sections 13–18.	Lot 4, sections 19–24.	Lot 5, sections 25–30.	Lot 6, sections 31–36.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	H. J. Loonam, Tinsley, Miss	16	17	16	16	16	28
2	Lucian Bland, Point Pleasant, La	.....	.....	a15.19	.....	.....	.....
4	H. Morgan, Tinsley, Miss	18.50	.....	.....	.....	.....	.....
6	H. F. Garbish, Point Pleasant, Miss.	19.75	21	19	19	19	28
7	Helgason Bros., Lehman, La	19	22	16.45	18	17.45	30
8	L. R. Bobbitt, Mark, La	a16.20	a16.70	15.70	a16.50	a16.50	28

a Accepted.

No. 1.—*Abstract of proposals received in response to advertisement (circular) dated May 25, 1899, etc.*—Continued.

LOWER TENSAS LEVEE DISTRICT—Continued.

No.	Name and address of bidder.	Evergreen-Bondurant Levee.					
		Lot 7, sections 37–42.	Lot 8, sections 43–48.	Lot 9, sections 49–54.	Lot 10, sections 55–60.	Lot 11, sections 61–67.	Lot 12, sections 68–73.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	H. J. Loonam, Tinsley, Miss	32	28	a 14.50	12	16	12
3	James R. Marlow, L'Argent, La	.....	.....	.....	.....	.....	13½
4	H. Morgan, Tinsley, Miss	.....	.....	.....	14.50	19	14.50
5	Hearin & O'Connor, Baton Rogue, La	.....	.....	.....	20.50	19.25	17.50
6	H. F. Garbish, Point Pleasant, La	30	a 24.75	21	16	17	15
7	Helgason Bros., Lehman, La	35	27	17.50	14.95	17.90	15
8	I. R. Bobbitt, Mark, La	32	29	17.75	13½	18	14½

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 12, 1899.

No. 2.—*Abstract of proposals received in response to advertisement (circular) dated July 1, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Evergreen-Bondurant Levee.				
		Lot 6, sections 31–36.	Lot 7, sections 37–42.	Lot 10, sections 55–60.	Lot 11, sections 61–67.	Lot 12, sections 68–73.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	James R. Marlow, L'Argent, La	.....	.....	.....	18	a 12.90
2	Helgason Bros., Lehman, La	30	35	13.95	16.95	13.95
3	Clark & Reagan, Plaquemine, La	.....	.....	13.60	17.50	13.75
4	Batt O'Brien, Tinsley, Miss	34	37.50	14.48	18.75	14.98
5	M. L. Linnan, Cinclare, La	.....	.....	14.94	18.98	15.97

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 11, 1899.

No. 3.—*Abstract of proposals received in response to advertisement (circular) dated July 12, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name and address of bidder.	Section 81.	Section 82.
		Cents.	*Cents.*
1	Clark & Reagan, Red River Landing, La	a 10.50	a 10.50

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 13, 1899.

No. 4.—*Abstract of proposals received in response to advertisement (circular) dated July 12, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Evergreen-Bondurant Levee—No. 10, sections 55-6
		Cents.
1	Clark & Reagan, Red River Landing, La	13

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 17, 1899.

No. 5.—*Abstract of proposals received in response to advertisement (circular) dated August 7, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LAKE BORGNE LEVEE DISTRICT.

No.	Name and address of bidder.	Chalmette levee.		Kenilworth levee.		Mary levee.	Harris levee.	
		Section 1.	Section 2.	Sections 1-2.	Sections 3-4.		Section 1.	Section.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Chas. H. Smith, New Orleans, La	15.90	a 15.90	a 14.90	a 14.90	16.80	16.84	1[illegible]
2	H. G. Seeligson, New Orleans, La	16.94	16.94	16.72	16.72	.....	.....	.....
3	Leonce Roy, New Orleans, La	a 14.75	.....	.....	.....	.....	.....	.....
4	F. W. Gleason, Dalcour, La	.....	.....	.....	.....	16	.....	.....
5	F. M. McLaughlin, Anchor, La	18	18	18	18	.....	19	19

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 17, 1899.

No. 6.—*Abstract of proposals received in response to advertisements (circular) dated August 7, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

BARATARIA LEVEE DISTRICT.

No.	Name and address of bidder.	Upper Magnolia.			Little Rock.	Belle Chasse.		Alliance.
		Section 1.	Section 2.	Section 3.		Section 1.	Section 2.	
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	A. Dobard & V. Brooks, Jesuit Bend, La	.....	.....	.....	.....	.....	.....	16.50
2	F. M. McLaughlin, Anchor, La	a 16.75	16.75	16.75	16.75	a 16.75	a 16.75	16.75
5	Chas. H. Smith, New Orleans, La	17.90	17.90	17.90	15.90	19.40	19.40	14.90
7	H. B. Turcan, Naomi, La	.....	.....	.....	.....	.....	.....	16
9	Michael Cullen, New Orleans, La	.....	.....	.....	.....	.....	.....	a 14.90
10	H. G. Seeligson, New Orleans, La	17.90	17.90	17.90	a 14.90	20.72	20.72	.....
11	Robert McNamara, New Orleans, La	18	a 16	17	15	20	20	16
12	John F. Meyer, English Turn, La	.....	.....	.....	15.90	.....	.....	.....

No. 6.—*Abstract of proposals received in response to advertisements (circular) dated August 7, 1899, etc.*—Continued.

BARATARIA LEVEE DISTRICT—Continued.

No.	Name and address of bidder.	St. Rosalie to Ironton.		Orange farm.		Reddick.	Nairn extension.	Rodey extension.	
		Section 1.	Section 2.	Section 1.	Section 2.			Section 1.	Section 2.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	A. Dobard & V. Brooks, Jesuit Bend, La	17.25	17.50	.....	.....	.....	.....	.....	.....
2	F. M. McLaughlin, Anchor, La	18.75	18.75	.....	.....	.....	.....	19	19
3	S. D. Bartolo, Nairn, La	.....	.....	.....	.....	.....	24	.....	.....
4	J. B. Easterling, Buras, La	.....	.....	.....	.....	14.50	.....	19	21.5
5	Chas. H. Smith, New Orleans, La	a15.90	15.90	16.24	16.24	18.24	a14.90	14.9	14.9
6	Gus. H. Schoenberger, Triumph, La	.....	.....	.....	.....	a14.50	.....	.....	.....
7	H. B. Turcan, Naomi, La	16	16	.....	.....	.....	.....	.....	.....
8	John Cleary, New Orleans, La	.....	.....	15¼	a14¼	16	.....	.....	.....
9	Michael Cullen, New Orleans, La	.....	a15.90	a15.45	15.45	.....	15	.....	.....
11	Robert McNamara, New Orleans, La	17	a17	19	19	16	16	15.50	.....
13	P. Harnan, New Orleans, La	.....	.....	.....	.....	.....	.....	a14.90	a14.90

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., August 26, 1899.

No. 7.—*Abstract of proposals received in response to advertisement (circular) dated July 1, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Evergreen-Bondurant Levee, lot No. 11.
		Cents.
1	Helgason Brothers, St. Joseph, La	a14.95

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 31, 1899.

No. 8.—*Abstract of proposals received in response to advertisement (circular) dated July 1, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Evergreen-Bondurant Levee, lot No. 7.
		Cents.
1	Batt O'Brien, St. Joseph, La	a22

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., July 31, 1899.

No. 9.—*Abstract of proposals received in response to advertisement (circular), dated July 1, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Evergreen-Bondurant, Lot No. 1.
		Cents.
1	Helgason Bros., St. Joseph, La	a 20

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 4, 1899.

No. 10.—*Abstract of proposals received in response to advertisement (circular) dated August 23, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LAKE BORGNE LEVEE DISTRICT.

No.	Name and address of bidder.	Mary levee.	Harris levee.	
			Section 1.	Section 2.
		Cents.	*Cents.*	*Cents.*
1	L. Daunoy, Dalcour, La	15.75		
2	Michael Mitchell, New Orleans, La		15	15
3	John Cleary, New Orleans, La		a 13.50	a 14.50
4	Michael Cullen, New Orleans, La		15.25	15
5	Robert McNamara, New Orleans, La		15.50	15.50
6	J. B. Easterling, Buras, La		15.75	15.75
7	F. M. McLaughlin, New Orleans, La	a 13.50		

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 25, 1899.

No. 11.—*Abstract of proposals received in response to advertisement (circular) dated August 31, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Catfish Bayou Dike.	Minnehaha.	Esperanza.	Glasscock.
		Cents.	*Cents.*	*Cents.*	*Cents.*
1	Helgason Bros., St. Joseph, La	a 17.50	a 12.78		
2	Dameron & White, New Orleans, La		20		
3	W. A. Miller, Fairview, La				26
4	L. M. Dalgarn, Natchez, Miss				33
5	James R. Marlow, St. Joseph, La		14.97	35	
6	Joseph Curry, St. Joseph, La		12.74		

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 25, 1899.

No. 12.—*Abstract of proposals received in response to advertisement (circular) dated August 31, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

ATCHAFALAYA LEVEE DISTRICT.

No.	Name and address of bidder.	Watson.	Buouci.	Hermitage.	Devall.	Barroza.	Homestead.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	M. L. Linnan, Cinclare, La	14.97	15.99	.....	.....	.....	14.98
2	F. M. McLaughlin, Baton Rouge, La.	15	15	29.75	26	26	16
3	George Byrne, Mark, La	21.50	15	.....	.....	.....	17.50
4	Dameron & White, New Orleans, La.	.....	.....	.....	35	35	.....
5	Donovan & Daley, New Orleans, La.	.....	.....	29.75	.....	.....	15.70
6	Mississippi Levee Construction Co., New Orleans, La.	.....	.....	.....	27	27	14.20
7	Ogden Bros. & Park, Baton Rouge, La.	23.99	13.94	.....	.....	.....	23.99
8	Helgason Bros., St. Joseph, La	.....	.....	.....	.....	.....	a13.95
9	N. P. Philips, Red River Landing, La.	a13.25	a12	.....	.....	.....	.....
10	Jno. F. Irvine, Bayou Sara, La	.....	13.97	.....	.....	.....	.....
11	John G. Ryan, New Texas, La	.....	12.45	.....	.....	.....	.....
12	J. W. Whipple & Son, New Roads, La.	.....	15	.....	.....	.....	.....
13	Sam Robertson, Sulphur, La	15.98	14.97	44.90	19.50	a22.50	18.45

No.	Name and address of bidder.	Port Allen.	Limerick.	Cinclare.	Brusly.	St. Delphine.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	M. L. Linnan, Cinclare, La	15.50	19.85	13.98	14.99	22.50
2	F. M. McLaughlin, Baton Rouge, La.	17.50	17.50	16.25	16.25	a16.25
3	George Byrne, Mark, La	.....	22	a12.87	17.50	19.50
5	Donovan & Daley, Plaquemine, La.	17	16.50	13.40	15.40	18.40
6	Mississippi Levee Construction Co., New Orleans, La	14.20	14.20	18.50	18.50	.....
7	Ogden Bros. & Park, Baton Rouge, La	18.94	.....	22.97	.....	.....
8	Helgason Bros., St. Joseph, La	a13.30	a14.20	18	14.45	.....
12	J. W. Whipple & Son, New Roads, La.	15	.....	12.75	a14	.....
13	Sam Robertson, Sulphur, La	17.40	22.50	17	17.50	18

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 25, 1899.

No. 13.—*Abstract of proposals received in response to advertisement (circular) dated August 31, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LAFOURCHE LEVEE DISTRICT.

No.	Name and address of bidder.	Jamestown.	Delogny.	Oak Alley.	Willow Grove.	Alliance.	Ashton.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	M. L. Linnan, Anchor, La	.....	25.50	a14.50	.....	.....	.....
2	J. D. Willis, New Orleans, La	19	22	18	.....	.....	.....
3	Ogden Bros. & Park, Baton Rouge, La	.....	.....	.....	15.97	.....	.....
4	Hayes Bros., Hahnville, La	.....	.....	.....	.....	.....	18
6	Albert J. Lacaze, Wallace, La	.....	.....	.....	12	a12.75	.....
8	Donovan & Daley, Plaquemine, La.	16.90	18.70	16.50	14.70	15.70	15.70

No.	Name and address of bidder.	Ellington.	Alice.	Soniat.	Odier.	Willswood.	Starlight.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
4	Hayes Bros., Hahnville, La	18	.....	.....	.....	.....	.....
5	Edwin P. Brady, Waggaman, La	.....	.....	.....	20	14	24
7	John M. Lambert, St. Rose, La	.....	20	.....	.....	.....	.....
8	Donovan & Daley, Plaquemine, La.	15.70	15.50	19.70	14.90	.....	.....

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., September 25, 1899.

No. 14.—*Abstract of proposals received in response to advertisement (circular) dated August 31, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name and address of bidder.	Burtville.	Woodstock.	Manchac.	Granada.	Hermitage.	Towns.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	George Byrne, Mark, La	25	21.50	21.50	19.50	13.85	15
2	M. L. Linnan, Cinclare, La	19	18	18	13.99	13.49	13.48
3	Donovan & Daley, Plaquemine, La.	19.70	19.70	18.40	17.90	16.90	17.90
4	Ogden Bros. & Park, Baton Rouge, La	18.72	19.99	14.74	14.97	14.23	17.93
5	Mississippi Levee Construction Co., New Orleans, La	a12.49	a12.49	a12.49	a12.49	a11.52	a11.04
6	Dameron & White, New Orleans, La.	17.25	17.25	17.25	17.25	17.25	17.25
7	F. M. McLaughlin, Baton Rouge, La.	17.50	17.45	17.50	17.25	16.00	15.75
8	Helgason Bros., St. Joseph, La	14.50	14.50	14.50	15	14.50	14

No.	Name and address of bidder.	Leper Home.	Indian Camp.	Hard Times.	Landry.	Mount Olive.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	George Byrne, Mark, La	18.75	17.50	14.80	13.50	19
2	M. L. Linnan, Cinclare, La	15	15	16	.....	a14
3	Donovan & Daley, Plaquemine, La.	a14.40	a14.40	a14.40	13.90	14.50
4	Ogden Bros. & Park, Baton Rouge, La.	22	17.93	16.74	a12.97	13.91
6	Dameron & White, New Orleans, La.	17.50	17.50	17.50	18	18
7	F. M. McLaughlin, Baton Rouge, La.	.....	.....	.....	15.50	15.50
8	Helgason Bros., St. Joseph, La	.....	.....	.....	14.50	14.50
10	James R. Marlow, L'Argent, La	a11.70	.....	.....	.....	.....

No.	Name and address of bidder.	Forlorn Hope.	Golden Gate.	Thiery.	Lorio.	Point Clear.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	George Byrne, Mark, La	18.75	18.50	.....	.....	16
2	M. L. Linnan, Cinclare, La	14	14.50	.....	.....	17
3	Donovan & Daley, Plaquemine, La.	14.90	14.40	18	18	a14.40
4	Ogden Bros. & Park, Baton Rouge, La.	a11.80	a13.97	18	18	14.99
6	Dameron & White, New Orleans, La.	18	.....	.....	.....	.....
7	F. M. McLaughlin, Baton Rouge, La.	15	.....	a14	14	.....
8	Helgason Bros., St. Joseph, La	14.50	.....	.....	.....	.....
9	John Pollard, Sunshine, La	.....	.....	14.70	a13.99	.....

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 6, 1899.

No. 15.—*Abstract of proposals received in response to advertisement (circular) dated August 31, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Esperanza, sections 16-18.
		Cents.
1	Helgason Bros., St. Joseph, La	a19.70

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 15, 1899.

No. 16.—*Abstract of proposals received in response to advertisement (circular) dated October 26, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

ATCHAFALAYA LEVEE DISTRICT.

No.	Name and address of bidder.	Grand Bay.	Hermitage.	Devall.	Cypress Hall.
		Cents.	*Cents.*	*Cents.*	*Cents.*
1	Donovan & Daley, St. Joseph, La	.....	24.70	.....	.....
2	Ogden Bros. & Park, Baton Rouge, La	26.97	29.94	.....	.....
3	F. M. McLaughlin, Mark, La	25	25	.....	.....
4	Whipple & Scott, Bayou Sara, La	a24.60	21.45	.....	.....
5	W. F. Barbour & Son, Hermitage, La	.....	a19	.....	.....
6	William Bates, Norwood, Ark	.....	.....	27	27

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 15, 1899.

No. 17.—*Abstract of proposals received in response to advertisement (circular) dated October 26, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LAFOURCHE LEVEE DISTRICT.

No.	Name and address of bidder.	Jamestown.	Delogny.	Willow Grove.	Ashton.	Ellington.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Ogden Bros. & Park, Baton Rouge, La	.....	18.97	13.78	.....	.....
3	Hayes Bros., Killona, La	.....	.....	.....	a10.90	a10.90
4	Donovan & Daley, St. Joseph, La	a14.90	a15	18.40	13.90	13.90
5	Adolph Hymel & Co., Wallace, La	.....	.....	11.75	.....	.....
6	Henry A. Sherman, Lee, La	19	.....	.....	18	18
7	Albert J. Lacaze, Wallace, La	.....	.....	a10	.....	.....
8	John E. Ryan, St. Joseph, La	.....	.....	.....	12.65	12.65
9	William Bates, Norwood, Ark	.....	.....	.....	12.75	12.75

No.	Name and address of bidder.	Alice.	Soniat.	Odier.	Willswood.	Starlight.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Ogden Bros. & Park, Baton Rouge, La	15.47	17.99	19.97	17.99	.....
2	E. C. Royal, New Orleans, La	14.75	.....	.....	.....	20
3	Hayes Bros., Killona, La	15	16	.....	.....	.....
4	Donovan & Daley, St. Joseph, La	13½	.....	.....	13.90	.....
8	John E. Ryan, St. Joseph, La	12.50	.....	.....	.....	.....
9	William Bates, Norwood, Ark	12.75	15	15	.....	.....

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 15, 1899.

No. 18.—*Abstract of proposals received in response to advertisement (circular) dated October 26, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

PONTCHARTRAIN LEVEE DISTRICT.

No.	Name and address of bidder.	Forlorn Hope.	Point Clear.	Leper Home.	Indian Camp.	Hard Times.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Ogden Bros. & Park, Baton Rouge, La	a 11.80	14.96	18.99	14.96	15.73
2	F. M. McLaughlin, Mark, La			14.25		14
3	Thomas Whelan, Cofield, La	17.45	16.40	15.40	15.23	15.90
4	Batt O'Brien, St. Joseph, La	13.93	13.93	14.23	14.23	14.35
5	Hayes Brothers, Killona, La	16	16	15	15	15
6	Helgason Brothers, St. Joseph, La		13.98	13.43	13.93	
7	George Byrne, Cinclare, La	14	13.85	12.35	13.25	14
8	H. J. Loonam, St. Joseph, La	14.50	13.25	15.70	14	15
9	Israel R. Bobbitt, Hard Times, La	13	13	13	13	13
10	Lindsey & Noble, Bayou Sara, La		14	15.97	15.97	15.97
11	D. Meyer, Sunshine, La	14.48	17	16.70	15.80	13
12	Donovan & Daley, St. Joseph, La	13.40	12.90	12.90	a 12.90	a 12.
13	J. A. Weber, Cinclare, La	13.97	a 10.50	13.47	13.57	14.97
14	William Bates, Norwood, La	14				
15	James R. Marlow, L'Argent, La			a 11.70		

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., November 27, 1899.

No. 19.—*Abstract of proposals received in response to advertisement (circular) dated November 16, 1899, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LOWER TENSAS LEVEE DISTRICT.

No.	Name and address of bidder.	Glascock.		
		Lot No. 1.	Lot No. 2.	Lot No. 3.
		Cents.	*Cents.*	*Cents.*
1	Henry A. Sherman, Lee, La	16.50	a 16.50	16.50
2	Loonam & St. John, St. Joseph, La	20	20	a 20
3	L. C. LeCorgne, New Orleans, La	a 17.25	17.25	20
4	Batt O'Brien, St. Joseph, La	20		

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., March 10, 1900.

No. 20.—*Abstract of proposals received in response to advertisement (circular) dated February 28, 1900, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

ATCHAFALAYA LEVEE DISTRICT.

No.	Name and address of bidder.	Devall.	Cypress Hall.
		Cents.	*Cents.*
1	J. S. McLaughlin, Baton Rouge, La	26	26
2	Ernest Hyner, Greenville, Miss	a 15.47	a 15.47
3	Israel R. Bobbitt, Baton Rouge, La	17.90	17.90
4	Stone & Stansell, Rosedale, Miss	21	21
5	Ogden Bros. & Park, Baton Rouge, La	18.40	18.40
6	McCadden & Co., Memphis, Tenn	16.90	16.90
7	M. J. Roach, Memphis, Tenn	21.50	21.50
8	J. B. Craven, New Orleans, La	17.40	19.10
9	Donovan & Daley, Island, La	17	18.45

a Accepted.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., March 10, 1900.

No. 21.—*Abstract of proposals received in response to advertisement (circular) dated February 28, 1900, opened this day by Maj. George McC. Derby, Corps of Engineers, for levee work in the Fourth district, improving Mississippi River.*

LAFOURCHE LEVEE DISTRICT.

No.	Name and address of bidder.	Alice.	Soniat.	Odier.	Willswood.	Starlight.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
1	Robert McNamara, New Orleans, La.	.....	.....	.....	16	.....
2	M. L. Linnan, Sunshine, La.....	11.44	12.44	.....	.....	.....
3	Donovan & Daley, Island, La.....	10.40	13.40	.....	11.90	.....
4	J. S. McLaughlin, Baton Rouge, La.	15	15	15	15	15
5	John G. Sessions, Memphis, Tenn...	11.97	12.97	14.27	11.97	20.27
6	J. B. Craven, New Orleans, La.....	13	15.25	17.75	13.20	13.90
7	E. C. Royal, New Orleans, La.....	.....	.....	.....	.....	18
8	F. M. McLaughlin, Baton Rouge, La.	a 9.35	10.75	14	10	18
9	George Byrne, Manchac, La.....	12.90	.....	.....	.....	.....
10	Michael Cullen, New Orleans, La...	.....	.....	.....	.....	20.25
11	W. F. Barbour & Son, New Orleans, La.....	14	14	19.98	a 8.80	.....
12	Ogden Bros. & Park, Baton Rouge, La.....	12.40	12.90	14.90	15	.....
13	McCadden & Co., Memphis, Tenn...	13.74	13.74	13.74	13.74	13.74
14	M. J. Roach, Memphis, Tenn	12.40	13.40	14.40	13	23.50
15	Thomas Whelan, Cofield, La.....	10.99	17.50	18.25	15.25	.....
16	Clark & Reagan, Geismar, La.....	12	16.90	12.43	15.23	25
17	Stone & Stansell, Rosedale, Miss....	14.24	14.24	14.24	14.24	14.24

a Accepted.

APPENDIX 5 H.

Contract in force, Fourth district, improving Mississippi River, with names of contractors, dates of approval of contracts, dates of beginning work, expiration of time for completion, and extensions granted.

No.	Nature of contract.	Name of contractor.	Date of approval.	Date of beginning work.	Date of expiration of contract.	Extension of time granted.
1	Six-decked barges.	Elizabeth Marine Ways Co.	Sept. 25, 1899	Mar. 7, 1900	Nov. 17, 1899	Mar. 17, 1900 May 17, 1900 July 17, 1900

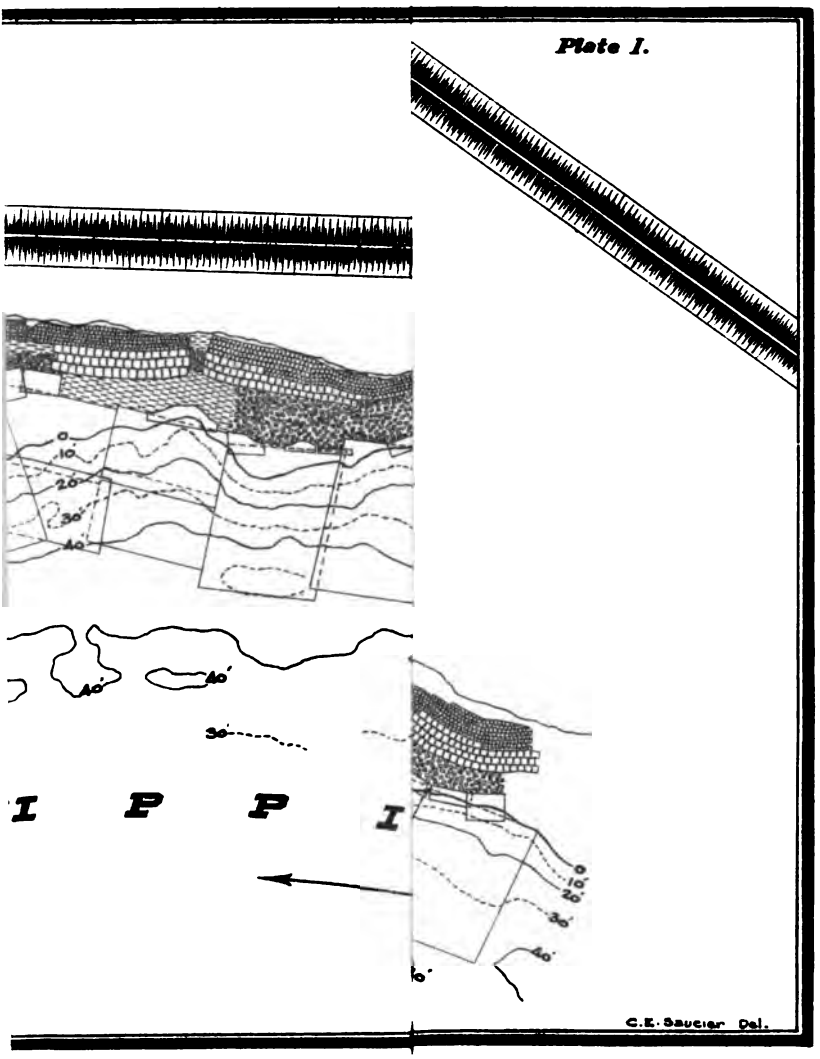

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Plate III.

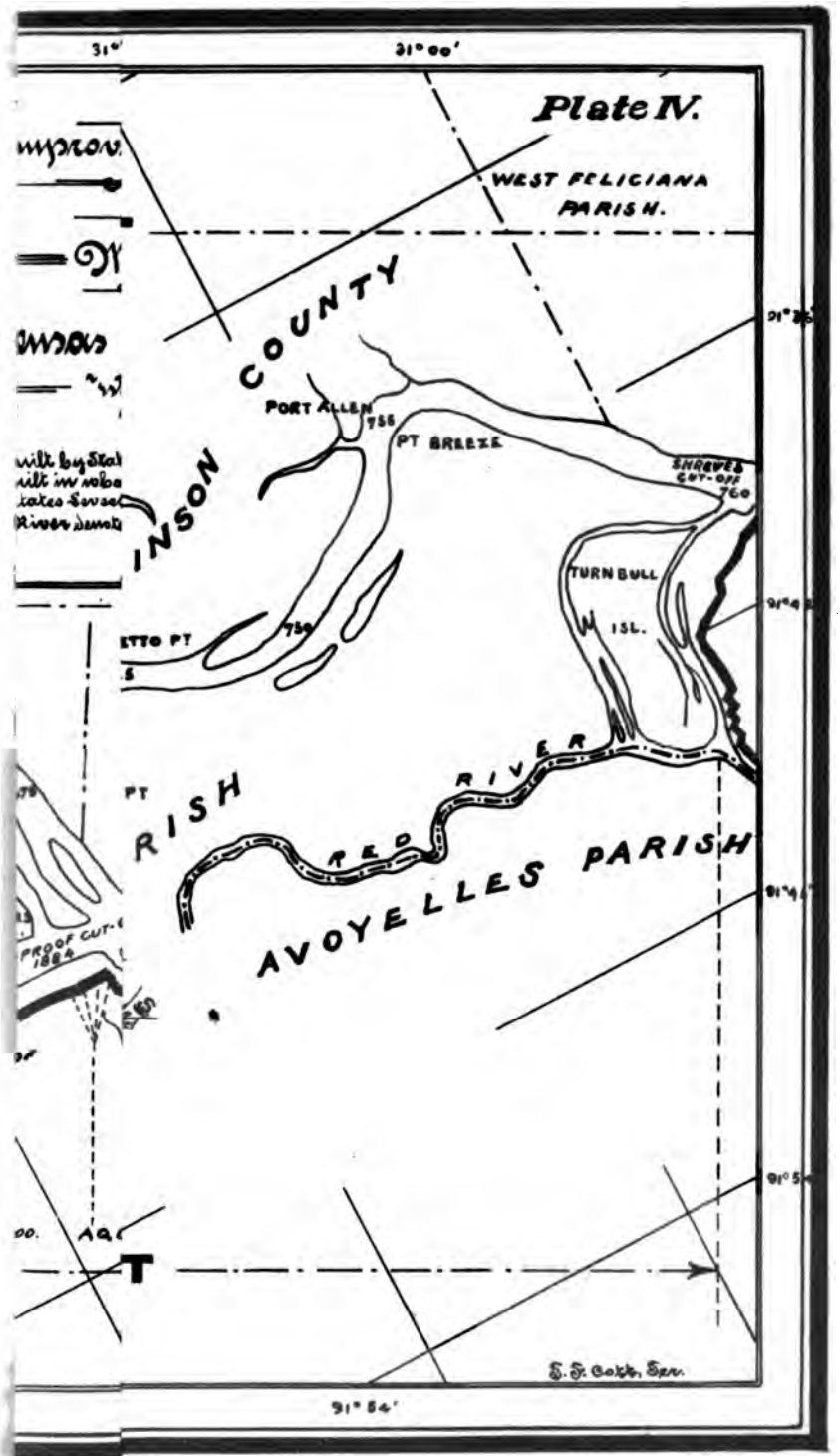
Plate IV.
WEST FELICIANA PARISH.
COUNTY
PORT ALLEN
PT BREEZE
SHREVES CUT-OFF
TURN BULL
ISL.
ETTO PT
RED RIVER
AVOYELLES PARISH
PROOF CUT
S. T. Cobb, Sur.
91° 54'

Eng 56 2

90°24'
THE BAPTIST

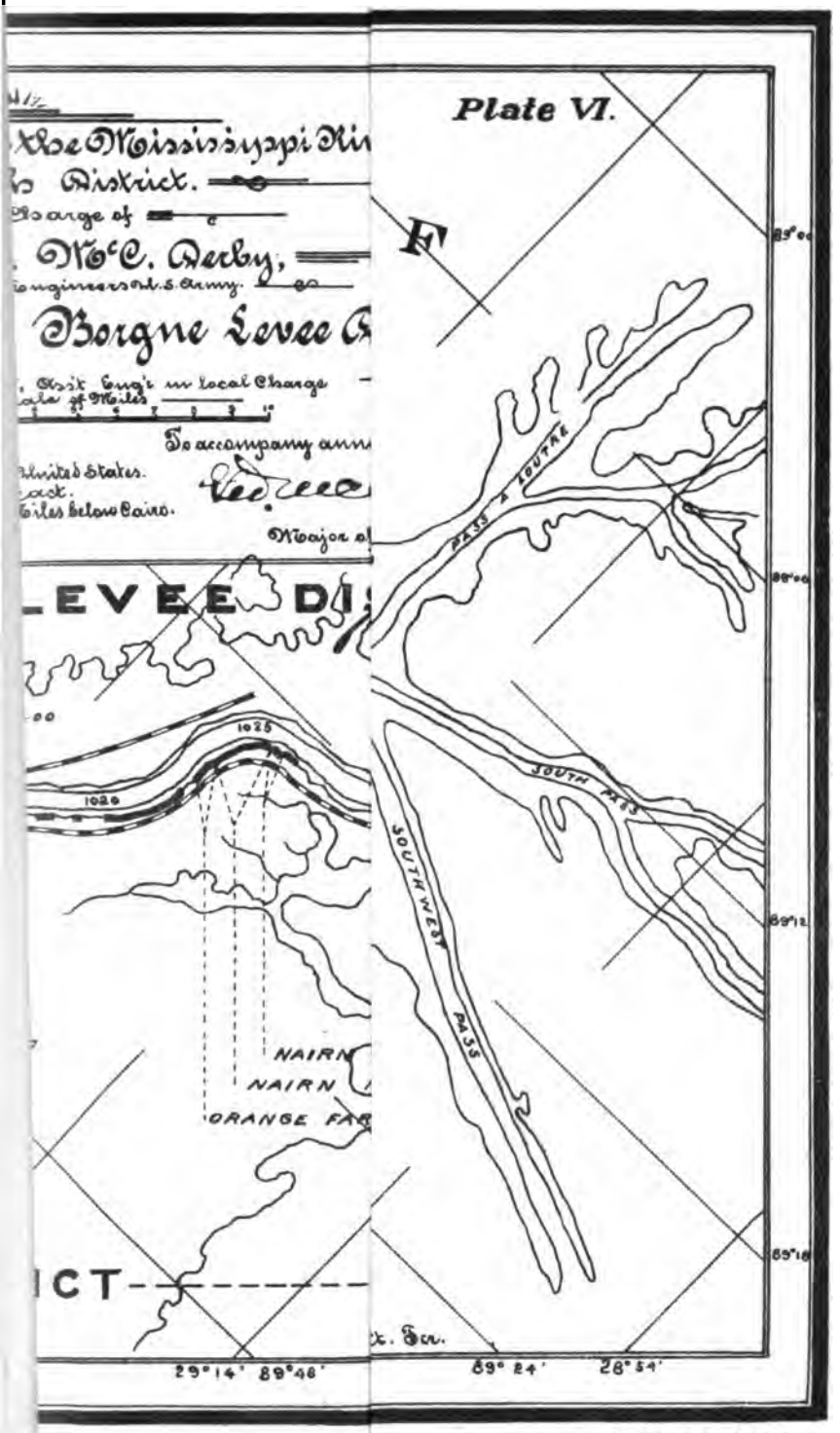
Plate VI.
Borgne Levee
LEVEE DI
PASS A LOUTRE
SOUTH PASS
SOUTH WEST PASS
1025
1026
NAIRN
NAIRN
ORANGE FA
89°00
88°00
89°12
89°18
29°14'
89°48'
89° 24'
28°54'

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APPENDIX Z Z.

ANNUAL REPORT OF THE MISSOURI RIVER COMMISSION FOR THE FISCAL YEAR ENDING JUNE 30, 1900.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., July 12, 1900.

SIR: The Missouri River Commission has the honor to submit herewith its annual report for the fiscal year ending June 30, 1900.

ORGANIZATION AND MEETINGS OF THE COMMISSION.

No change occurred in the personnel of the Commission during the year.

The duties of the secretary were performed by Capt. H. M. Chittenden from July 1, 1899, to October 14, 1899, when he transferred these duties, pursuant to Special Orders, No. 223, Headquarters of the Army, Adjutant-General's Office, Washington, September 23, 1899, to the president of the Commission, who performed them until relieved on November 17 by First Lieut. (now Capt.) Charles Keller, Corps of Engineers, who reported on that date for duty, pursuant to the provisions of the above-mentioned order.

The Commission held two sessions during the past year, July 12, at St. Louis, and October 21–29, on board of the U. S. snag boat *C. R. Suter*, when a tour of inspection was made.

APPROPRIATIONS AND ALLOTMENTS.

The urgent deficiency act approved January 5, 1899, contained the following item:

For continuing and completing the work of protecting the bank in Pelican Bend, Missouri River, one hundred thousand dollars. And this sum shall be deducted from the sum of three hundred thousand dollars authorized to be appropriated and expended for continuing improvement of the Missouri River from its mouth to Sioux City, Iowa, for the fiscal year ending June thirtieth, nineteen hundred, by the "Act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," which became law on June third, eighteen hundred and ninety-six.

The river and harbor act, approved March 3, 1899, contained the following items:

For improving the Missouri River from its mouth to Sioux City, Iowa, according to plans and specifications of the Missouri River Commission, one hundred thousand dollars: *Provided*, That of this amount the following sums, or so much thereof as may be necessary, in the discretion of the Secretary of War, shall be expended for continuing improvements at the following places, namely: For work at the mouth of the Kaw River, in Missouri, five thousand dollars; for work on the right bank above the mouth of Little Blue River, in Missouri, five thousand dollars; for work above Glasgow, Missouri, ten thousand dollars; for work near Huntsdale, Missouri, ten thousand dollars; for local work above Kansas City, Missouri, not yet completed, twenty thousand dollars; for repairs on works and contingencies, fifteen thousand dollars; *Provided also*, That of the said amount of one hundred thousand dollars the

sum of thirty-five thousand may be expended in operating snag souri River between Sioux City and its mouth, in removing snags obstructions.

Improving Gasconade River, Missouri: Continuing improveme dollars.

Improving Osage River, Missouri, by the construction of a lock ance with the plan and estimate submitted by the Missouri Ri their report of July twelfth, eighteenth hundred and ninety-ei Volume Six of the Report of the Chief of Engineers for the yea and ninety-eight, twenty-five thousand dollars: *Provided*, That th may enter into a contract or contracts for such work and materia sary for the completion of such lock and dam, or the materials and the work done otherwise than by contract, to be paid for as from time to time be made by law, not to exceed in the aggregat forty-six thousand dollars, exclusive of the amount herein and priated.

The sundry civil act, approved March 3, 1899, conta ing item:

Improving Missouri River from mouth to Sioux City, Iowa: For ment of Missouri River from its mouth to Sioux City, Iowa, inclu ical, office, traveling, and miscellaneous expenses of the Missouri surveys, permanent bench marks, and gauges, two hundred thou *vided*, That of this amount the following sums, or so much there sary, in the discretion of the Secretary of War, shall be exp improvement at the following places, namely: Saint Joseph, Misso dollars; Omaha, Nebraska, and Council Bluffs, Iowa, fifty thousa Leavenworth, Kansas, five thousand dollars; Jefferson City, Mis sand dollars to improve the harbor at Jefferson City by compelli channel of the river to the south side thereof; Nigger Bend, Mis dollars; Randolph Bend, Missouri, fifteen thousand dollars; L ten thousand dollars.

At its meeting of the 14th of March, 1899, the Com mended the following allotments from the above appro were approved by the Chief of Engineers and Secreta

From river and harbor act:

For work at the mouth of the Kaw River	
For work on the right bank above the mouth of Little Blue	
For work above Glasgow, Mo	
For work near Huntsdale, Mo	
For work, local works above Kansas City, Mo	
For work in first reach	
For work, repairs, and contingencies	
For work, operating snag boat	
For new plant	
For general office expenses	
Total	

From the sundry civil act:

For work at Omaha and Council Bluffs	
For work at St. Joseph, Mo	
For work opposite Leavenworth, Kans	
For work at Randolph Bend, Mo	
For work above mouth of Little Blue River	
For work at Lexington, Mo	
For work above Glasgow, Mo	
For work at Nigger Bend, Mo	
For work at Jefferson City, Mo	
For new plant	
For repair and contingencies	
For surveys, gauges, physical data, etc	
For salaries of the Commission, travel and general office exp	
Total	

The sum appropriated in the urgent deficiency act was specifically appropriated for the work at Pelican Bend, and no allotment by the Commission was necessary.

In the approved allotments from the appropriations contained in the river and harbor act and in the sundry civil act approved March 3, 1899, the following changes were made, with the approval of the Chief of Engineers:

April 13, 1900, the following transfers were made to the allotment for "Repairs and contingencies:"

From opposite Leavenworth	$2,000
At mouth of Kaw	1,000
At Nigger Bend	1,000
Total	4,000

The sundry civil act approved June 6, 1900, contained the following items:

For improving the Missouri River from its mouth to Sioux City, Iowa: For continuing the improvement, including salaries and expenses of the Missouri River Commission, two hundred and fifty thousand dollars, to be expended under the direction of the Secretary of War in the improvement of the river at such localities as may be absolutely necessary in order to preserve existing improvements and to prevent threatened damage near Rulo, Nebraska, and other points; said work to be done according to plans and specifications to be made by the Missouri River Commission and approved by the Chief of Engineers.

Improving Osage River, Missouri: For completing constuction of lock and dam, one hundred and forty-six thousand dollars.

At a meeting on July 12, 1900, the Commission recommended the following allotments from the above appropriation, which have yet to receive the approval of the Chief of Engineers and Secretary of War:

For work, near Rulo, Nebr	$65,000
For work, local works above Kansas City, Mo. (to be distributed approximately as follows: At Omaha and Council Bluffs, $4,000; at St. Joseph, Mo., $10,000; at Nebraska City, Nebr., $17,000)	31,000
For work, local works below Kansas City, Mo. (to be distributed approximately as follows: Above mouth of Little Blue River, $15,000; above Glasgow, Mo., $12,000; near Rocheport, Mo., $10,000; at Howards Bend, above St. Charles, Mo., $10,000)	47,000
For work in first reach	65,000
For work, operating snag boat	15,000
For surveys, gauges, physical data, etc	7,000
For office and traveling expenses and salaries of Commission	20,000
Total	250,000

SURVEYS AND EXAMINATIONS.

During the past year preliminary examinations, surveys, and reports thereon were from Rocheport, Mo., to the mouth of Terrapin Creek, and near Napoleon, Mo.

GAUGES AND PHYSICAL DATA.

On the Missouri River 22 permanent water gauges were maintained throughout the year independently of those maintained in connection with works of improvement, their records being reported weekly to this office.

Through the courtesy of the engineer officer in charge of the river above Sioux City, the weekly records of the gauges at Bismarck,

N. Dak., Townsend, Mont., and Fort Benton, Mon
nished during portions of the year.

Hydrographs of all the gauges were kept platted
errors made manifest were at once traced and correc

A few small repairs were required during the
nance of the gauges. During the fall one inspection

All pilot bulletin service was suspended in Decemb
tion of the bulletin at Kansas City, which was cont
entire year.

The four permanent gauges on the Osage and th
conade were continued without interruption. Fo
regarding the gauges see report of Assistant Engine
Appendix A.

REMOVAL OF OBSTRUCTIONS.

The snag boat *Charles R. Suter* was in commissio
to November 8, during which time she was engaged
and other obstructions from the river and in an insp
Commission.

During the year 751 snags were removed and 318
banks. The distance run on this work and on the in
1,579 miles.

COMMERCE.

The statistics of commerce were collected as usual d
year. They show the following comparison with
ending December 31, 1899:

Missouri River	
Osage River	
Gasconade River	

For tables of statistics see report of Assistant
Blaisdell, Appendix B.

CONSTRUCTION.

OMAHA REACH.

Operations comprised the construction of 700 lin
ment and of two pile dikes, the upper of which wa
lower 550 feet long, all of these being on the left
Creek. The revetment was successfully finished i
standard specifications. Due to a change in the direc
which caused it to chord the bay above the dikes, and
scour caused by a succession of small rises, on May
bents of the upper dike were carried away. May 2
end of the lower dike was badly damaged. More r
shows that the attack on these dikes is no longer
channel seems to be moving from them and nearer

NEBRASKA CITY REACH.

In this reach work has consisted in repairs to the dikes near Nebraska City. The principal work was the repair of the outer curved end of Dike No. 5, which had been carried away by the flood of June 24, 1899. The work was begun on November 18 and, but for the failure of the contractors to deliver piling as required, could have been completed before the close of the season within the estimates. As it was, the work was not completed until about April 1, much additional expense having been incurred on account of difficulties due to cold, ice, and flood. The dike was very successful in training the channel during the time that it remained undamaged. A breach, due to change in direction of channel flow, was made in the outer curved end of this dike on June 10, 1900. Dike 1 was flanked and Dikes 2 and 3 were slightly damaged by ice and eddy action and have called for small repairs. The attack has once more moved outward and the closure of Dike 1 will be comparatively easy.

ST. JOSEPH REACH.

The new work consisted in the construction of 2,659 feet of standard revetment beginning at a point about 7,800 feet below the bridge. Slight repairs were made to the curtain of the pile dikes which close the gaps in the Bon Ton and Belmont revetments.

RANDOLPH, MO.

One thousand two hundred linear feet of revetment were built on the left bank of the river in front of the town of Randolph. Some difficulty was encountered, due to a continual shifting in the stage of water.

LITTLE BLUE REACH.

In this reach, owing to lack of funds, it has been necessary to attempt to make a single dike do work that properly required at least two dikes.

Dike 2 A.—As reported in the last Annual Report, this dike was breached during the high water of April, 1899, and the shore end was flanked. When operations were resumed in August, 1899, it was found that the shore had receded and the destruction of the dike itself had continued so that the length of dike necessary to close the opening was 830 feet. The closure was completed in September, 1899. Ice movement in March again damaged the structure and stripped it of a large portion of its curtain. Slight repairs were made in April, 1900, and the curtain partially restored. A rise on June 10, 1900, made a breach 90 feet long in this dike.

Revetment construction.—Four hundred and sixty linear feet of practically standard revetment were built between August 25 and September 16, 1899, at the head of Blue Mills Island. Extensive accretions near the head of the island and in the Independence Chute Channel south of it made further protection unnecessary.

LEXINGTON REACH.

Four dikes, extending out from the left bank in the bend above the town of Lexington, were built for the purpose of causing and maintain-

ing a higher crossing to the bluffs on the Lexingto
tally, of protecting the river terminus of the At
Santa Fe Railroad. The work was begun early i
and carried on until the threatened exhaustion of fu
ber caused its cessation with the dikes in an unfini
curtains being lacking throughout most of their
feet of 3-row work were built. Additions to the
in April, 1900. Dike No. 4 was breached by ice
examination in June shows the breach to be increa

MIAMI REACH.

Dike 1 B was repaired in September, 1899, 70 l
work being required to close the gap then existing
and Bankhead 1 B have done the work expected of
good condition, additional work will be required
in this reach.

GLASGOW REACH.

Bankhead 5 C.—The work of remodeling this st
in progress at the beginning of the fiscal year, w
several temporary suspensions on November 25.

The general plan consisted in masking the upper
sion of the outer wall of the old bankhead to a jun
with a 2-row pile dike, the outer row having a radi
connecting the pile work by radial curtains with
intervals of 40 feet; also the breaking up of eddy
bankhead by a radial pile dike, abatis, or other wo
lay in the 1,000-foot curve produced. All the work
forming the elements of a sloping berm 50 feet in
cone of a 1 on 2 slope.

Bankhead 6 C.—This structure was remodeled
plan as 5 C, between dates of August 5 and Nove
greater difficulties were encountered owing to
velocities.

During the flood of 1899 the paved berm and up
badly damaged. The berm was restored by a se
stone dikes and the upper cone was rebuilt.

In the break-up of the ice the lower radial dik
injured and, it appearing that its location was too
vent eddy action, an additional radial dike was bui
above it.

Bankhead 4 C.—This structure was remodeled by
sion built on the same general lines as the other tw
75 feet in width. It was completed between Augus

The conditions of flow in Wilhoites Bend were
after the completion of the bankheads, and it was
greater improvement would follow after the recur

The first break-up of ice occurred in January, whe
was low, and the bankheads required but slight rep
damage to the bankheads was due to the movement
when the river was at an unusually high stage. T
were subjected to violent attack, more particularly
and it is noticeable that the lower portions of the b

intact, while a considerable number of the high piles and much of the bracing and wales were broken or found missing, necessitating repair and reinforcement, which was completed between March 28 and April 28.

Since the repair of the bankheads they have very satisfactorily accomplished the work for which they were designed, and there has been practically no recession of the bank which they were intended to protect.

When the work was last examined, June 21, at a stage of 12.2 feet above standard low water, the conditions in Wilhoites Bend appeared to be very favorable.

Bankhead 2 C.—This incomplete structure was considerably damaged during the flow of ice and flood water, the full extent of which can not be determined until the water falls.

Dike 3 C.—This dike is in good condition for 240 feet of its length. No work was done on it during the year.

CAMBRIDGE BEND REVETMENT.

This bank revetment, about 4,400 feet in length, was placed by the Chicago and Alton Railway Company in the fall of 1889. Its preservation is important, as any project for the improvement of the reach below would necessarily include it. Some 950 tons of stones and spawls were expended in its reenforcement. A recent examination showed that a breach 200 feet in length has occurred near its lower end, and at two other places there were indications of settlement.

The improvement of the bend and the point opposite Glasgow, in Saline County, Mo., was made the subject of a special report to the Department by the president of the Commission under date of June 18.

NIGGER BEND.

The old United States revetment built in 1889 at the head of this bend, about 3,900 feet in length, was extended downstream 738 feet, with an average width of mat of 90 feet. The new work was constructed between May 17 and June 3, is of standard specification, and overlaps the old work 25 feet.

A slight settlement in the upper bank work of the old revetment, near its head, was repaired by the expenditure of 45 cubic yards of spawls, distributed evenly over about 90 linear feet of bank.

ROCHEPORT REACH.

Bankhead 1 D.—The work of remodeling this structure by pilework extension upstream on the same general plan as on the bankheads in Wilhoites Bend was in progress at the beginning of the fiscal year.

High water greatly interfered with the work, necessitating some auxiliary and additional structures as it progressed.

During the ice movement early in January, the pile work received considerable damage, which was partially repaired in April.

HUNTSDALE REACH.

The project at this point contemplated the placing of about 825 linear feet of standard revetment at the head of the cutting bank just

below the accretions formed by the two lines of ab
December, 1898. The work was performed betwe
April 17. The accretions formed by the abatis ha
raised during the past year, and are covered with yo

HOWARDS BEND REACH.

No work was done on this reach. The three bank
remained uninjured.

The great bar formerly between bankheads 5 F an
scoured out. There has been no bank caving during
bankheads 5 F and 6 F, and none of any consequenc
5 F. There has been some caving above 4 F, and
about 125 feet long has formed in the bank, causin
eddy. The flow past 5 F and 6 F was comparatively
eddy. Some work should be done in the reach for b

PELICAN BEND REVETMENT.

Between dates of August 10 and December 27 an
March 30 the revetment of 1898–99 was extended 1,
and 7,741 feet downstream. The total length of con
now in the bend is 15,198 feet as measured on the st
contour. No further work appears necessary for the
bend.

ICE HARBOR.

As an economical measure, for the care of plant i
during the winter months, an ice harbor was establis
ferry, on the right bank, about 17 miles above the m

GASCONADE DIVISION.

AT JEFFERSON CITY, MO.

The approved project called for the construction o
and hurdle combined, and 1 dike, which were built,
feet of abatis, 234 feet of hurdle, and 801 feet of dik
tion 651 feet of revetment were built to hold the upp
head opposite Jefferson City. The object of all
restore the original approved line of rectification
and this object has been largely accomplished. Abs
damaged by drift; the other works are intact.

CHAMOIS REACH.

Seven hundred and sixty feet of the upper wor
revetment were repaved, this portion having been
scouring of a sand bar which obstructed the bank w
was built.

Chamois bankhead.—This structure, built in the
received no attention during the year. It appears
condition. There has been practically no caving of

o foot of Chamois revetment, a distance of 3,600 feet, and none below or a distance of 1,200 feet, although these stretches of bank are otherwise unprotected, and for most of the time the main volume of the low has passed in front of the bankhead.

DAMAGES.

The most important injuries sustained during the year by works nder charge of the Commission, in addition to those mentioned, were s follows:

Bon Ton Bend revetment.—One of the old breaks near the head of his revetment, which had been closed by pile work, has extended omewhat upstream and downstream.

Dikes A, A', and B, above Leavenworth, Kans.—These structures nd the sheer dikes above them, built in 1897, were injured more or less y ice during the past winter. The shore connection and three bents re all that remain of Dike A. The injuries to the other two dikes are ear their outer ends, which were submerged when the examination was made. The sheer dikes have been practically destroyed.

Dikes opposite Leavenworth.—Several bents near the stream ends of Dikes Nos. 1 and 2, built in 1895, have been broken down by ice, eaving a gap between the structure and trail.

Little Platte Bend works (constructed 1887 to 1891).—The dikes at he head of the bend and about 3,200 linear feet of the revetment have been entirely destroyed. The destruction of the revetment by flanking is going on at a rapid rate.

Quindaro revetment.—This revetment, built in 1885, is in bad condition. About 6,000 linear feet of upper bank work is all that was visible at the time of the last examination. From about 600 feet below the head of the revetment to its present lower end there are numerous small breaks. Below the present terminus of the revetment to within 1,000 feet of the head of Grand Island a bank protection of heavy fascine work has been put in by the Kansas City, St. Joseph and Council Bluffs Railway Company.

Kaw Point revetment.—This revetment, built in 1890, has three breaks in the upper bank work in the localities of about 500, 700, and 800 feet below the head of the work. The upper two are of minor importance, the lowest one is about 75 feet in length and will probably increase.

East Bottoms revetment (built in 1887).—There are five breaks in this work, aggregating 620 feet in length.

Murrays Bend revetment.—The break in this revetment has increased to 425 feet, which length has been completely destroyed. The attack is now so direct that continued damage seems probable.

Dike 33 B.—The remainder of this dike was destroyed.

Dike 33 C.—Nearly two-thirds of this dike has been destroyed.

Dike XXVIII A.—The trail and 27 bents of the outer end were scoured out and carried away in July. This dike was originally too long, and the loss of its outer end has caused no damage to the channel.

Dike II.—This was breached in two places during July, the two breaches together aggregating about 200 feet in length.

Dike XXIII.—A breach, due to the direct attack of the river, about 110 feet long, was made in this dike.

PLANT.

The construction of the 12 new barges mentioned in the last report was greatly retarded by the failure to secure prompt delivery of the necessary oak and fir lumber. Two barges were completed and launched in October. The other 10 average about 75 per cent toward completion. Existing plant was cared for and the necessary repairs made. In addition to the towboats belonging to the Government, two private boats were chartered during the year. Two barges were wrecked and lost.

SURVEYS AND REPORTS.

In connection with the progress of the work, frequent surveys were made showing the condition at various points and also numerous special examinations and reports upon different localities.

For details of the work, see the reports of Division Engineer S. Waters Fox, Appendices C, D, and E.

OSAGE RIVER.

The original project for the improvement of this stream, adopted in 1871, consisted in the removal of obstructions to navigation, such as snags and leaning timber, in deepening the channel over shoals by means of dredging, and in the construction of cross and wing dams to concentrate the water over the shoal places.

The original estimated cost of the project was $230,000, but afterwards the work was made to cover more ground than was originally intended, and for a number of years past no estimate of the cost of the improvement by this method has been rendered in the Annual Reports. From the nature of the project, which contemplates only temporary relief from year to year and the removal of obstructions which are constantly forming anew, no definite time can be fixed for its completion and no estimate made for its ultimate cost. The improvement must be continuous, and the annua lestimates must depend upon conditions as they arise.

Under a new project the construction of a lock and dam near the mouth of the river was authorized by the river and harbor act of September 19, 1890.

Owing to the small amounts of money appropriated for its construction, only $50,000 once in two years, it was necessary to defer actual construction until a sufficient amount had accumulated to warrant commencement of work. With the exception of acquiring title to the necessary grounds and the erection of a lock house and office, nothing of importance was done until the summer of 1896. Work on the lock was then begun under contract. Before it had proceeded far, however, complications arose on account of the necessity of lowering the reference of the miter sill 5 feet. An equitable arrangement could not be made with the contractors for the additional work involved in this change. It was therefore decided to purchase their plant and to carry on the work directly by hired labor. The bargain was made and the contract surrendered June 30, 1896.

The original project, under which work had been carried on up to this time, contemplated a structure of stone masonry 376 feet long between quoins and 52 feet clear width. Before resuming work this

project was modified so as to reduce the size of the lock to 220 feet by 42 feet and to substitute concrete for stone masonry in the construction. A complete revised project for the lock and a project for the dam were approved by the Chief of Engineers June 29, 1897. The total estimated cost, including previous expenditures, is $325,000. The amount expended by the General Government under these projects to June 30, 1900, is $417,676.90;[1] amount expended during past fiscal year is $12,909.72; amount of indebtedness that was incurred under the authorized contract of Pollard & Wallace of May 16, 1899, is $117,477.99.

On May 16, 1899, a contract was entered into with Messrs. James S. Pollard and Joseph D. Wallace covering most of the work, to be paid for as appropriations may from time to time be made by law, while the rest was to be done directly by hired labor and purchase of materials in open market.

Work was promptly begun under the contract as soon as it was approved, but an unusually prolonged high water, which caused the deposit of a large amount of sediment in the cofferdam, delayed the work considerably. The scarcity of labor and its poor quality when obtainable also retarded progress, so that when operations were suspended early in December the work on the contract was only about three-fourths completed.

Early in the progress of work under this contract considerable discrepancies began to manifest themselves between the quantities mentioned in the printed specifications under which the work was being done and the quantities actually required. Claims for damages due to this cause were set up by the contractors, but after some correspondence with them an agreement was entered into, with the approval of the Chief of Engineers, whereby the contract was disposed of by the payment of the full amount of the last estimate, with additional compensation at market rates for all material on hand. The contractors agreed to leave their plant on the ground for the use of the United States until the completion of the lock and dam, the United States agreeing to pay the sum of $2,500 as plant hire.

As a result of this agreement the work will now be completed by hired labor and the purchase of material in open market.

At the close of the fiscal year the lock walls were completed, the gates were ready for their anchorages, and the paving of the slopes above and below the locks about two-thirds done. Seven piers, seven sections of the fixed dam, and the abutment on the right bank were finished, and frames for the weir and fixed circle were in place in these sections. Some sheathing of the fixed circle had been done. Two piers and three sections of the dam remained untouched. The machinery for maneuvering the gates and the movable sections of the dam remained to be placed.

There is every prospect that the work will be completed early this fall.

The work is under the charge of Capt. Charles Keller, Corps of Engineers, secretary of the Commission, with Mr. F. B. Maltby in immediate supervision. For further details see report of Assistant Engineer F. B. Maltby, Appendix F.

[1] Amount stated for fiscal year ending June 30, 1899, was incorrect. Correct amount disbursed on general improvement is $226,222.31; lock and dam is $191,454.59.

The officer in charge renews the recommendation of that the work of canalization on this river be suspende pletion of Lock and Dam No. 1, and that open chann tinued wherever required, and this recommendation i the Commission.

For commercial statistics see report of Assistant Blaisdell, Appendix B.

GASCONADE RIVER.

The project for the improvement of this stream, ac consisted in the removal of snags and logs from the leaning timbers from the banks of the river where nec construction of wing dams and training walls to conc of water upon the shoals to increase the depth over th

From the nature of the project, which contemplates relief from year to year, and the removal of obstruct constantly forming anew, no definite time can be fixed tion, and no estimate made of its ultimate cost. The imp be continuous, and the annual estimates must depend u as they arise.

The original estimated cost of the project was $50,00 cipal work contemplated by it has been accomplished, just stated the work can never be considered complete

The amount expended under the project to Ju $68,014.94,[1] of which sum $7,402.42 was expended durin

Field work consisted in the construction of dams at Woodpecker Island, Brants, and Turnpike shoals. T considerable relief to navigation. Two barges were labor for use on this work. The river was thoroughly from Priors Ferry to the mouth, a distance of 35 mile

The work is under the direction of Capt. Charles Engineers, secretary of the Commission, with Assistant Maltby in local charge.

The officer in charge repeats the recommendation of approved by the Commission, in favor of open channe of this river.

For further details see report of Assistant Enginee Appendix G.

For commercial statistics see report of Assistant Blaisdell, Appendix B.

RECOMMENDTIONS AND ESTIMATES.

MISSOURI RIVER.

Attention is invited to the following recommendat substantially as made in former reports of the Commis

In their reports the Commission has called attenti quacy of the annual appropriations under recent act satisfactory progress being made in the work of conti ment, especially as these acts have provided that large s for improvements at widely detached localities.

[1] Amount stated for fiscal year ending June 30, 1899, was

It was urgently recommended that such localities be provided for by separate legislation, while the annual general appropriation should be used solely on the continuous improvement of the river by reaches, in accordance with the Congressional act of September, 1890.

Should this policy be pursued for a few years, the progress of the systematic work, under more economical methods, would soon become evident and commerce would begin to reap the benefit of the improvement.

In view of the difficulties that are experienced in carrying out the project adopted, arising from the limited appropriations made and from the allotment of large portions of these to special localities, it is recommended that when necessity arises for work at a special locality the appropriation should be sufficiently large to cover a sub or minor reach in the general project which may include this locality. In this way the work that may be done under these legislative allotments will be made to fall in with the adopted project for the general improvement, and some progress may be made toward carrying it to a conclusion.

As appears from a reading of this report, under the present policy of alloting the funds appropriated, the improvement of the river for navigable purposes is making very slow progress.

There are localities lying in the first reach where the demands for improvement are most pressing, which would be reached in a short time could the systematic improvement be allowed to proceed unrestricted by diversion of funds to detached places.

The Commission would again call attention to the depleted floating plant now available for its work.

During the last three seasons' operations the work was frequently embarrassed for the want of sufficient carriers to prosecute the work vigorously and cheaply.

This adjunct can not be hired at reasonable cost, but should be kept up if the work is to be continued on the river.

It does not appear possible to properly provide for the plant by proportional taxation of the allotments made for detached places, as that would leave the balances left for improvement purposes too small for any useful effect. With a more liberal appropriation for the general improvement the plant could be gradually renewed and kept in condition at an expense which would not fall onerously on any of the works.

It is impracticable to carry on the work with any degree of efficiency for permanent useful results at the present rate of appropriations.

It is believed that the completion of work in the first reach, opening the river from its mouth to Jefferson City, would fully demonstrate either the advisability or the inadvisability of continuing the work of improvement in the upper reaches.

The work has not yet reached a development upon the Missouri River which would render it possible to submit an estimate for the annual cost of maintenance. Ever-varying conditions of ice and flood will cause this amount to vary. The same remarks apply to the Osage and Gasconade rivers.

OSAGE RIVER.

Assuming that the work on the lock and dam will be completed during the present season and that no further structures of this class will

be required, the sum recommended for the improvemen
under the original project is $25,000.

GASCONADE RIVER.

The amount recommended for the improvement under ex
is $15,000 per year.

Money statements.

IMPROVING MISSOURI RIVER FROM THE MOUTH TO SIOUX CIT

July, 1, 1899, balance unexpended.....
Amount appropriated by sundry civil act approved June 6, 1900...
Refunded on account of overpayments and transfers .....

June 30, 1900, amount expended during fiscal year.....

July 1, 1900, balance unexpended.....
July 1, 1900, outstanding liabilities.....

July 1, 1900, balance available.....

Amount that can be profitably expended in fiscal year ending Ju
30, 1902, in addition to the balance available July 1, 1900.....
Submitted in compliance with requirements of sections 2 of river a
harbor acts of 1866 and 1867 and of sundry civil act of June 4, 1897

IMPROVING OSAGE RIVER, MISSOURI AND KANSAS.

July 1, 1899, balance unexpended.....
Amount appropriated by sundry civil act approved June 6, 1900...
Refunded on account of overpayment.....

June 30, 1900, amount expended during fiscal year.....

July 1, 1900, balance unexpended.....
July 1, 1900, outstanding liabilities..... $4,7
July 1, 1900, amount covered by uncompleted contracts 117,4

July 1, 1900, balance available .....

Amount (estimated) required for completion of existing project...
Amount that can be profitably expended in fiscal year ending Jun
1902, in addition to the balance available July 1, 1900:
For works of improvement..... $20,0
For maintenance of improvement..... 5,0

Submitted in compliance with requirements of sections 2 of river
harbor acts of 1866 and 1867, of section 7 of the river and harbo
of 1899, and of sundry civil act of June 4, 1897.

[1] Indeterminate at present.

IMPROVING GASCONADE RIVER, MISSOURI.

July 1, 1899, balance unexpended	$14,926.85
June 30, 1900, amount expended during fiscal year	7,402.42
July 1, 1900, balance unexpended	7,524.43
July 1, 1900, outstanding liabilities	280.00
July 1, 1900, balance available	7,244.43
Amount (estimated) required for completion of existing project	(1)
Amount that can be profitably expended in fiscal year ending June 30, 1902, in addition to the balance available July 1, 1900:	
For works of improvement	$10,000.00
For maintenance of improvement	5,000.00
	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867, of section 7 of the river and harbor act of 1899, and of sundry civil act of June 4, 1897.

Respectfully submitted.

AMOS STICKNEY,
Lieut. Col., Corps of Engineers, U. S. A.
G. C. BROADHEAD,
THOS. H. HANDBURY,
Major, Corps of Engineers, U. S. A.
C. L. CHAFFEE,
W. L. MARSHALL,
Major, Corps of Engineers, U. S. A.

Brig. Gen. JOHN M. WILSON,
Chief of Engineers, U. S. A.

Financial statement from July 1, 1899, to June 30, 1900.

Work.	Balances July 1, 1899.					
	Appropriation act of Aug. 18, 1894.	Appropriation act of June 3, 1896.	Appropriation act of June 4, 1897.	Appropriation act of July 1, 1898.	Appropriation act of Jan. 5, 1899.	River and harbor appropriation act of Mar. 3, 1899.
Improving Missouri River from mouth to Sioux City, Iowa.						
Office and traveling expenses and salaries of Commission	.....	.....	.....	$2,402.71	.....	$9,000.00
Surveys, gauges, physical data and publications	.....	.....	.....	1,300.66	.....	.....
First Reach	.....	.....	.....	7,509.58	.....	13,500.00
Operating snag boat	.....	.....	.....	367.10	.....	25,000.00
Rectification of the river at Omaha, Nebr	.....	$87.87	.....	.....	.....	.....
At Atchison, Kans	$1,195.82	890.99	.....	.....	.....	.....
Opposite Leavenworth, Kans	.....	.....	.....	156.99	.....	.....
Vicinity of St. Joseph, Mo	.....	.....	.....	461.04	.....	.....
Mouth of Kaw River	.....	.....	.....	214.16	.....	1,000.00
Above mouth of Little Blue River	.....	.....	.....	1,205.70	.....	5,000.00
Above Glasgow, Mo	.....	.....	.....	.....	.....	5,329.92
Near Huntsdale, Mo	.....	.....	.....	7,507.89	.....	1,000.00
Pelican Bend and vicinity	.....	.....	.....	6.53	$100,000.00	.....
Local works above Kansas City, Mo	.....	.....	$973.51	.....	.....	16,000.00
Repairs and contingencies	.....	.....	.....	.....	.....	25.77
New Plant	.....	.....	.....	.....	.....	8,566.27
Total	1,195.82	978.86	973.51	21,132.36	100,000.00	79,421.96

[1] Indeterminate at present.

Financial statement from July 1, 1899, to June 30, 1900—Cont

Work.	Balances July 1, 1899.				
	Appropriation act of Aug. 18, 1894.	Appropriation act of June 3, 1896.	Appropriation act of June 4, 1897.	Appropriation act of July 1, 1898.	Ap pri ac Ju 1
Improving Osage River, Missouri and Kansas.					
Lock and dam (construction of lock, etc.)	.....	$259.13	.....	.....	.....
Snagging operations	.....	973.69	.....	.....	.....
Total	.....	1,232.82	.....	.....	.....
Improving Gasconade River, Missouri.					
Removal of snags and other obstructions	.....	127.52	.....	.....	.....
Grand total	$1,195.82	2,339.20	$973.51	$21,152.36	$100,

Work.	Balances July 1, 1899.		Received by transfer from other allotments.	Ref on a of pay e
	Sundry civil appropriation act of Mar. 3, 1899.	Sundry civil appropriation act of June 6, 1900.		
Improving Missouri River from mouth to Sioux City, Iowa.				
Office and traveling expenses and salaries of Commission	$13,000.00	.....	.....	.....
Surveys, gauges, physical data and publications	10,500.00	.....	.....	.....
First Reach	.....	.....	.....	.....
Operating snag boat	.....	.....	.....	.....
Rectification of the river at Omaha, Nebr.	40,000.00	.....	.....	.....
At Atchison, Kans.	.....	.....	.....	.....
Opposite Leavenworth, Kans.	2,000.00	.....	.....	.....
Vicinity of St. Joseph, Mo	.....	.....	.....	.....
At St. Joseph, Mo	24,000.00	.....	.....	.....
Mouth of Kaw River	.....	.....	.....	.....
Above mouth of Little Blue River	10,000.00	.....	.....	.....
Above Glasgow, Mo	8,000.00	.....	.....	.....
Near Huntsdale, Mo.	.....	.....	.....	.....
Pelican Bend and vicinity	.....	.....	.....	.....
Local works above Kansas City, Mo	.....	.....	$1,792.60	.....
	35,000.00	.....	4,000.00	.....
Repairs and contingencies	16,000.00	.....	.....	.....
At Jefferson City, Mo.	12,000.00	.....	.....	.....
At Randolph Bend, Mo.	.....	.....	.....	.....
At Lexington, Mo	8,000.00	.....	.....	.....
At Nigger Bend, Mo	8,000.00	.....	.....	.....
New Plant	13,500.00	.....	.....	.....
Continuing improvment	.....	$250,000.00	.....	.....
Total	200,000.00	250,000.00	5,792.60	
Improving Osage River, Missouri and Kansas.				
Lock and dam (construction of lock, etc.)	.....	146,000.00	.....	.....
Snagging operations	.....	.....	.....	.....
Total	.....	146,000.00	.....	
Improving Gasconade River, Missouri.				
Removal of snags and other obstructions	.....	.....	.....	.....
Grand total	200,000.00	396,000.00	5,792.60	

Financial statement from July 1, 1899, to June 30, 1900—Continued.

Work.	Amount expended to May 31, 1900.	Expended during month of June, 1900.	Total amount expended to June 30, 1900.	Transferred to other allotments.	Total balances June 30, 1900.	Outstanding liabilities June 30, 1900.	Balances available June 30, 1900.
Improving Missouri River from mouth to Sioux City, Iowa.							
Office and traveling, expenses and salaries of Commission	$17,122.74	$1,867.28	$18,990.02	.....	$5,412.69	$653.41	$4,759.28
Surveys, gauges, physical data and publications	8,213.79	250.00	8,463.79	.....	3,336.87	488.90	2,847.97
First Reach	8,894.85	451.79	9,346.64	.....	11,663.74	944.12	10,719.62
Operating snag boat	18,910.23	936.45	19,846.68	.....	5,520.42	186.83	5,333.59
Rectification of the river at Omaha, Nebr	24,011.01	9,174.59	a 33,185.60	.....	6,902.27	1,639.92	5,262.35
At Atchison, Kans	.....	.....	.....	.....	2,086.81	.....	2,086.81
Opposite Leavenworth, Kans	156.99	.....	156.99	$2,000.00	.....	.....	.....
Vicinity of St. Joseph, Mo	461.04	.....	461.04	.....	.....	.....	.....
At St. Joseph, Mo	24,000.00	.....	24,000.00	.....	.....	.....	.....
Mouth of Kaw River	113.35	.....	113.35	1,000.00	100.81	.....	100.81
Above mouth of Little Blue River	11,947.91	.20	11,948.11	.....	4,257.59	539.83	3,717.76
Above Glasgow, Mo	13,302.82	27.10	13,329.92	.....	.....	.....	.....
Near Huntsdale, Mo	7,160.67	19.40	7,180.07	.....	1,327.82	9.25	1,318.57
Pelican Bend and vicinity	92,959.98	259.95	93,219.93	.....	6,786.95	361.65	6,425.30
Local works above Kansas City, Mo	18,739.57	6.11	18,745.68	.....	20.43	20.43	.....
Repairs and contingencies	38,180.03	268.55	38,448.58	.....	577.19	6.69	570.50
At Jefferson City, Mo	15,814.96	7.66	15,822.62	.....	177.38	.....	177.38
At Randolph Bend, Mo	6,154.49	5,325.30	11,479.79	.....	520.21	429.58	90.63
At Lexington, Mo	7,931.17	.....	7,931.17	.....	68.83	.....	68.83
At Nigger Bend, Mo	536.84	4,935.55	5,472.39	1,000.00	1,627.61	960.80	666.81
New Plant	17,028.35	.....	17,028.35	.....	37.92	.....	37.92
Total	381,640.79	23,529.98	355,170.72	4,000.00	300,325.54	6,641.41	293,684.13
Improving Osage River, Missouri and Kansas.							
Lock and dam (construction of lock, etc.)	12,045.12	468.60	12,513.72	.....	158,746.16	122,110.67	36,635.49
Snagging operations	396.00	.....	396.00	.....	577.69	99.00	478.69
Total	12,441.12	468.60	12,909.72	.....	159,323.85	122,209.67	37,114.18
Improving Gasconade River, Missouri.							
Removal of snags and other obstructions	7,364.27	38.15	7,402.42	.....	7,524.43	280.00	7,244.43
Grand total	351,446.18	24,036.68	375,482.86	4,000.00	467,173.82	129,131.08	338,042.74

a Includes the sum of $1,792.60 transferred to local works above Kansas City, Mo., for construction material shipped from Nebraska City, Neb.

Detailed statement, July 5, 1884, to June 30, 1900.

Work.	Balance of appropriations of 1882.	Appropriations and allotments.	Refunded on account of overpayment, etc.	Total available.	Expended to May 31, 1900.	Expended during the month of June, 1900.	Total expended to June 30, 1900.	Total balances June 30, 1900.	Outstanding liabilities June 30, 1900.	Balance available June 30, 1900.
Survey of the Missouri River above the Missouri River Falls, Fort Benton, Mont.	.....	$15,000.00	.....	$15,000.00	$15,000.00	.....	$15,000.00	.....	.....	.....
Between Fort Benton, Mont., and Sioux City, Iowa.										
Office and inspection expenses of district officer	$2,000.00	4,749.00	.....	6,749.00	6,749.00	.....	6,749.00	.....	.....	.....
Purchase and repair of plant	2,000.00	58,751.00	.....	60,751.00	60,751.00	.....	60,751.00	.....	.....	.....
Work below Fort Benton	.....	31,500.00	.....	31,500.00	31,500.00	.....	31,500.00	.....	.....	.....
Improving Missouri River between Sioux City and Fort Benton	.....	48,250.00	$0.75	48,250.75	48,250.75	.....	48,250.75	.....	.....	.....
Survey between Fort Benton and Sioux City	.....	73,250.00	1.72	73,251.72	73,251.72	.....	73,251.72	.....	.....	.....
Office expenses and expenses of Commission	.....	5,000.00	53.24	5,053.24	5,053.24	.....	5,053.24	.....	.....	.....
Expenses proper of Commission, gauges, and physical data	.....	3,500.00	20.62	3,520.62	3,520.62	.....	3,520.62	.....	.....	.....
	4,000.00	225,000.00	76.33	229,076.33	229,076.33	.....	229,076.33	.....	.....	.....
Survey of Missouri River from its mouth to Fort Benton	8,844.39	.....	.....	8,844.39	8,844.39	.....	8,844.39	.....	.....	.....
Between Sioux City, Iowa, and the mouth of the river.										
Office and traveling expenses and salaries of Commission	.....	251,000.00	719.02	251,719.02	244,439.05	$1,867.28	246,306.33	$5,412.69	$653.41	$4,759.28
Surveys, gauges, physical data, and publications	.....	416,275.00	90.36	416,365.36	412,778.49	250.00	413,028.49	3,336.87	988.90	2,347.97
Expenses proper of Commission, gauges, and physical data	.....	33,800.00	188.97	33,988.97	33,988.97	.....	33,988.97	.....	.....	.....
Systematic improvement, First Reach	.....	2,544,700.00	272.62	2,544,972.62	2,532,857.09	451.79	2,533,308.88	11,663.74	944.12	10,719.62
Operating snag boat (removal of snags, etc.)	1,982.80	366,425.00	19.40	368,427.20	361,970.33	936.45	362,906.78	5,520.42	186.83	5,333.59
Construction, repair, and care of plant	.....	458,864.84	12.75	458,877.59	458,839.67	.....	458,839.67	37.92	.....	37.92

Sioux City, Iowa		80,411.67		80,411.67	80,411.67		80,411.67			
Arrow Rock, Mo		36,294.98		36,294.98	36,294.98		36,294.98			
Miami, Mo		19,787.67		19,787.67	19,787.67		19,787.67			
Local works above Kansas City, Mo		52,792.60		52,792.60	52,766.06	6.11	52,772.17	20.43	20.43	
Local works below Kansas City, Mo		322,000.00	.85	891,000.35	865,758.80	10,575.16	876,333.96	14,666.39	2,201.11	12,465.28
Continuing improvement		250,000.00								
Total	1,982.80	6,911,792.60	1,896.74	6,915,172.14	6,591,316.67	28,529.98	6,614,846.60	300,325.54	6,641.41	293,684.13
Improving Osage River, Missouri and Kansas.										
Lock and dam (construction of lock, etc.)		342,855.18	.75	342,855.93	183,641.17	468.60	184,109.77	158,746.16	122,110.67	36,635.49
Snagging operations		9,366.44		9,366.44	8,788.75		8,788.75	577.69	99.00	478.69
Examination of the stream		800.00		800.00	800.00		800.00			
Total		353,021.62	.75	353,022.37	193,229.92	468.60	193,698.52	159,323.85	122,209.67	37,114.18
Improving Gasconade River, Missouri.										
Removal of snags and other obstructions		24,638.11		24,638.11	17,075.58	88.15	17,113.68	7,524.43	280.00	7,244.43
Examination of the stream from mouth to Arlington		500.00		500.00	500.00		500.00			
Total		25,138.11		25,138.11	17,575.58	88.15	17,613.68	7,524.43	280.00	7,244.43
Grand total	14,827.19	7,529,952.33	1,473.82	7,546,253.34	7,055,042.84	24,036.68	7,079,079.52	467,173.82	129,131.08	338,042.74

Consolidated statement, July 5, 1884, to June 30, 1900

IMPROVING MISSOURI RIVER FROM MOUTH TO SIOUX CITY,

Act of July 5, 1884	$640,000.
Act of August 5, 1886	375,000.
Act of August 11, 1888	1,000,000.
Act of February 22, 1890	75,000.
Act of September 19, 1890	800,000.
Act of July 13, 1892	600,000.
Act of March 3, 1893	700,000.
Act of August 18, 1894	700,000.
Act of March 2, 1895	710,000.
Act of June 3, 1896	300,000.
Act of June 4, 1897	300,000.
Act of July 1, 1898	300,000.
Act of January 5, 1899	100,000.
Act of March 3, 1899 (river and harbor)	100,000.
Act of March 3, 1899 (sundry civil)	200,000.
Act of June 6, 1900 (sundry civil)	250,000.
Total specific appropriations	
Balances from former appropriations:	
Act of August 2, 1882, applied to works above Sioux City, Iowa	$4,000.
Survey of Missouri River from mouth to Fort Benton	8,844.
Act of August 5, 1886, applied to removing obstructions from Missouri River	1,982.
Total balances	
Refunded on account of overpayment, etc.	
Total	

IMPROVING OSAGE RIVER, MISSOURI AND KANSAS.

Act of August 18, 1894	$46,000.
Act of June 3, 1896	50,000.
Act of March 3, 1899	25,000.
Act of June 6, 1900	146,000.
Balances transferred January 15, 1895, from Maj. Chas. J. Allen, Corps of Engineers:	
Act of September 19, 1890	42,655.
Act of July 13, 1892	43,366.
Refunded on account of overpayment	
Total	

IMPROVING GASCONADE RIVER.

Act of August 18, 1894	$5,000.
Act of June 3, 1896	5,000.
Act of March 3, 1899	15,000.
Balance transferred January 15, 1895, from Maj. Chas. J. Allen, Corps of Engineers:	
Act of July 13, 1892	138.
Total	
Grand total	
Expended to June 30, 1900:	
For improving Missouri River	$6,867,767.
For improving Osage River	193,698.
For improving Gasconade River	17,613.
Total	
Balance June 30, 1900	

List of civilian engineers employed on work of river and harbor improvements in charge of Missouri River Commission, in connection with improving Missouri River from its mouth to Sioux City, Iowa, improving Osage River, Missouri and Kansas, and improving Gasconade River, Missouri.

Name and residence.	Time employed.	Compensation per month.	Where employed.
	mos. ds.		
S. Waters Fox, Jefferson City, Mo	12 0	$250	Jefferson City, Mo.
A. H. Blaisdell, St. Louis, Mo	12 0	250	St. Louis, Mo.
James A. Seddon, St. Louis, Mo	1 0	200	Do.
F. B. Maltby, St. Louis, Mo	12 0	250	Osage River; construction of lock and dam.
Saml. F. Crecelius, St. Louis, Mo	5 0	125	Gasconade River; in field.
	2 0	125	St. Louis, Mo.
R. A. Crawford, Jefferson City, Mo	12 0	150	Gasconade division; local works below Kansas City.
W. R. De Witt, Jefferson City, Mo	12 0	150	Gasconade division; local works below Kansas City.
S. W. Benedict, Jefferson City, Mo	16	75	Gasconade division; local works below Kansas City.
	7 2	100	
O. H. B. Turner, St. Louis, Mo	6 18	100	Gasconade division; local works below Kansas City.
Ed. Jones, Nebraska City, Nebr	12 0	150	Local works above Kansas City.

APPENDIX A.

ANNUAL REPORT ON WATER GAUGES, BY MR. A. H. BLAISDELL, ASSISTANT ENGINEER.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1900.

CAPTAIN: I have the honor to submit the following report on water gauges during the fiscal year:

The Commission has maintained on the Missouri River 22 permanent gauges, of which 17 are cable gauges on bridges and the remainder inclined wooden ones on shore.

One temporary gauge maintained by field party is in its seventh year of continuance.

One complete tour for inspection and repairs made during October has sufficed to keep the gauges in serviceable condition. The few necessary repairs made have been inexpensive.

The pilot-bulletin service, exhibiting the daily stage from the same zeros as the United States Weather Bureau, was maintained for the entire year at Kansas City, and until December 1 at the 11 gauge stations below.

Abstracts of the weekly gauge reports have been mailed regularly to field parties, current hydrographs have been kept platted to date, corrected hydrographs completed in ink, and the greater part of the manuscript copy of gauge readings for the preceding five years prepared for printing.

Weekly reports of 3 gauges above Sioux City have been regularly received, through the courtesy of the engineer officer in charge.

The stages during July and August were higher than those of the same months during the preceding four years, and during the fall months were generally below the average fall stage and more regular in decline.

The highest water of the year from the mouth to Glasgow occurred during the break up of the ice in March; from De Witt to Plattsmouth during the third week of June and from Omaha to Sioux City during the second week in April.

The highest local stage, about 1 foot below standard high water, was recorded at Nebraska City on June 18.

A rise cresting at 8.7 feet above the low water of 1889 passed Bismarck June 3, and was locally considered as the "June rise" although it was 3.3 feet below the average high water stage.

The 4 gauges on the Osage and 1 on the Gasconade River were continued.

The hydrographs of these rivers show the usual fluctuating stages during the months of July, March, April, May, and June, but none of the rises exceeded the ordinary.

Very respectfully, your obedient servant,

A. H. BLAISDELL, *Assistant Engineer.*

Capt. CHARLES KELLER,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

APPENDIX B.

ANNUAL REPORT ON COMMERCIAL STATISTICS BY MR. A. H. BLAISDELL, A

MISSOURI RIVER
St. Louis, Mo

CAPTAIN: I have the honor to submit the following report on th Missouri River between its mouth and the lower limits of Sioux the calendar year 1899:

The statistics were obtained in the same manner as in previous made by individual shippers and from the special commerce cards the water-gauge observers.

The following table giving the amount of freight carried, tow passengers carried, but not including any direct ferriage, is beli approximation to the actual river trade, although owing to the dif the business done by the smaller class of shippers it is doubtless s the actual amount:

TABLE 1.

Class.	Grain.	Live stock.	Wood and lumber.	Sand and building materials.	General merchandise, farm machinery, etc.	Total.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Long-trade packets	179	15	441	.....	80	715
Short-trade packets and miscellaneous boats	17,525	2,606	8,452	3,923	5,104	37,610
Sand and wood steamers and barges	.....	.....	2,067	216,447	.....	218,514
Rafts	.....	.....	6,275	.....	.....	6,275
Total	17,704	2,621	17,235	220,370	5,184	263,114

a Including 225,485 excursion passengers.

The secretary of the St. Louis Merchants' Exchange reports th 1899 the number of arrivals and departures of steamboats and barg Missouri River were 11 and 14, respectively.

The steamer *Gus Fowler*, tonnage 309, entered the river at the grain-shipping season as a regular packet. She made only two s long ones of about 190 miles, and was sunken by a hidden obstruc

In table 1 the freights of the long-trade packets comprise an carried by the *Gus Fowler* and manufactured lumber freighted by the from Lexington and Glasgow to Jefferson City.

The short-packet trade was carried on by small steamers and bar running as local packets, were employed as feeders by the railroad

Steamers having tonnages of 200 to 470 have found it profitabl excursion trade; two regular excursion steamers during the seas 190,663 passengers.

The following comparative table gives the totals for the differe for the series of years 1899–1894:

TABLE 2.

Class.	Total tons carrie			
	1899.	1898.	1897.	1896.
Long-trade packets	715	3,641	4,499	3,16
Short-trade packets and miscellaneous boats	37,610	39,245	40,476	52,79
Sand and wood steamers and barges	218,514	252,152	341,710	229,61
Rafts	6,275	5,755	4,344	3,14
Mattress brush furnished the United States under contract, for use on other works than those of the Missouri River Commission	.....	19,000	.....	19
Total	263,114	319,793	391,029	288,92

TABLE 2—Continued.

Class.	Mile-tons.					
	1899.	1898.	1897.	1896.	1895.	1894.
Long-trade packets	98,198	526,804	651,024	443,614	1,010,879	1,045,526
Short-trade packets and miscellaneous boats	410,580	522,872	447,433	1,064,568	965,536	729,862
Sand and wood steamers and barges	422,606	359,948	473,459	281,205	240,988	156,846
Rafts	126,432	145,437	164,569	45,395	76,655	141,850
Mattress brush furnished the United States under contract, for use on other works than those of the Missouri River Commission	.....	375,000	.....	4,849	675,000	.....
Total	1,057,761	1,929,561	1,736,485	1,839,631	2,968,558	2,073,584

Class.	Passengers.					
	1899.	1898.	1897.	1896.	1895.	1894.
Long-trade packets		801	109	375	1,175	3,150
Short-trade packets and miscellaneous boats	a 239,022	b 79,102	2,541	1,538	5,373	c 3,312
Total	239,022	79,908	2,650	1,913	6,548	6,462

a Including 225,485 excursion passengers.
b Including 76,100 excursion passengers.
c Including 1,000 excursion passengers.

Three gasoline boats, engaged in short trade, carried an aggregate of 10,967 tons (117,024 mile-tons) during the year. Twelve gasoline boats, having an aggregate tonnage of about 200 tons, are reported as engaged in traffic on the river and its tributaries.

The number of merchant boats passing six of the water-gauge stations is given in the following table:

TABLE 3.

Locality.	Trade.	Number passed.		Registered tonnage.	
		Up.	Down.	Up.	Down.
Bellefontaine Bridge, Missouri	Towboats and packets	16	14	2,592	2,091
Coles Creek, Missouri	....do	178	179	8,450	8,536
Boonville, Mo	....do	92	92	3,899	3,843
Dewitt, Mo	....do	129	130	11,145	11,178
Kansas City, Mo	Excursions and packets	193	192	58,968	59,094
Omaha, Nebr	Excursions	70	70	32,830	32,830

Table 4 is a list of steam vessels licensed to navigate the Missouri River and its tributaries during the year 1899.

TABLE 4.—*List of steamers plying on the Missouri River in the distri during the year 1899.*

Name.	Where built.	Year.	Where enrolled.	Dime	
				Length.	
				Feet.	
A. W. Ewing	Osage City, Mo	1878	St. Louis, Mo		
C. H. Hugo	New Haven, Mo	1897	do	79.2	
Columbia	Osage, Mo	1898	do	80.5	
Commodore	New Haven, Mo	1890	do	97	
Dauntless	Tuscumbia, Mo	1898	do	59.3	
Fawn	Hermann, Mo	1880	do	91.9	
Frederick	Tuscumbia, Mo	1883	do	96.4	
Gasconade	L'Outre Island, Mo	1891	do	107.4	
Gus. Fowler *b*	Jeffersonville, Ind	1880	do	160	
Golden Gate	St. Louis, Mo	1878	do	131.4	
J. R. Wells	Tuscumbia, Mo	1898	do	110.6	
J. W. Spencer	Jeffersonville, Ind	1882	do	131	
Jack Rabbit	Mount Sterling, Mo	1897	do	73.6	
Jacob Richtman	Sterling Island, Mo	1898	do	160	
John R. Hugo	Evansville, Ind	1879	do	127	
Millboy	Hermann, Mo	1893	do	89.2	
Moline	Rock Island, Ill	1880	do	126.2	
Peerless	Hermann, Mo	1893	do	96.6	
Thomas Parker	St. Louis, Mo	1894	do	100	
New Haven	Pomeroy, Ohio	1892	do	101	
Annie Cade	Leavenworth, Kans	1879	Kansas City, Mo	127.5	
Ariel	Lexington, Mo	1897	do	84.6	
Carrie Cole	Chicago, Ill	1887	do		
Geo. W. Parker	Pittsburg, Pa	1879	do	266	
Jos. L. Stevens	Jeffersonville, Ind	1887	do	103	
Lois	Waverly, Mo	1896	do	75.2	
Nadine	Lamine, Mo	1892	do	75.3	
Navajo	Kansas City, Kans	1897	do	88.5	
Ranger	Papinsville, Mo	1898	do	36.2	
Lotus	Burlington, Iowa	1888	do		
Harry Lynds	White Cloud, Kans	1892	St. Joseph, Mo	64	
Castalia	Sioux City, Iowa	1892	Omaha, Nebr	110	
Josie L. K	Chamberlain, S. Dak	1896	do	60	
Little Maud	Sioux City, Iowa	1882	do	92	
Minnehaha	Canton, S. Dak	1893	do		
Queen No. 2	Tierville, Iowa	1879	do	44	
Mike Bauer	Brunswick, Mo	1892	do	65	
South Dacota	Running Water, S. Dak	1899	do	137.5	

a Estimated.

b Sunk August 22, 1899.

TABLE 4.—*List of steamers plying on the Missouri River in the district of New Orleans during the year 1899*—Continued.

Name.	Staterooms.	Berths.	Passengers.			Engines.			Boilers.				
												Flues.	
			Permitted to carry.	First cabin.	Steerage or deck.	Number.	Diameter.	Stroke.	Number.	Length.	Diameter.	Number.	Diameter.
							In.	*Feet.*		*Feet.*	*Inches.*		*Inches.*
A. W. Ewing			8		8	1	6	3	1	3	40	*a* 70	1½
C. H. Hugo			20		20	2	7	3	1	13	50	1	28
Columbia			10		10	2	7½	2½	1	11	34	*a* 28	3
Commodore			50		50	2	10	4	1	20	44	6	2-12 4- 6
Dauntless			19		19	2	5½	2	1	5	48 x 54		
Fawn			50		50	2	8	2	1	14	42	4	2-10 2-12
Frederick	4	13	28	13	15	2	7	2½	1	14	36	6	6
Gasconade	3	6	35	5	30	2	9	3½	1	20	42	6	2-10 4- 6
Gus. Fowler *b*	25	56	121	*c* 56 *d* 15	50	2	14	4	2	28	42	5	10
Golden Gate	8	16	66	16	50	2	16	4	2	28	40	2	14
J. R. Wells	5	10	20	10	10	2	10	4	1	18	44	10	6
J. W. Spencer						2	16	6	2	26	40		
Jack Rabbit			20		20	2	6	2	1	10	36	*a* 14	9-3 5-3½
Jacob Richtman	13	26	126	26	100	2	14	6	2	22½	44	34	3½
John R. Hugo	6	10	25	9	16	2	12½	3½	1	24	42	5	10
Millboy			20		20	2	8	3	1	14	44	1 *a* 26	24 3
Moline	6	12	25			2	14	5	2	24	40	12	8
Peerless	2	4	22		22	2	8	3	1	16	42	2 *a* 6	15 3
Thomas Parker	5	10	20	5	15	2	10	6	1	20	46	6	2-13 4- 7
New Haven						2	10½	3	2	20	36	4	12
Annie Cade						1	20	5½	2	16	42		
Ariel						2	9	3	1	18	42		
Carrie Cole			16		16	1	4½	1	1	4½	30		
Geo. W. Parker						2	22	7	4	26	42		
Jos. L. Stevens						2	10	3½	1	16	48		
Lois			21		21	2	7	2½	1	12	40		
Nadine			20		20	2	8	2	1	14	40	*a* 39	3
Navajo			25		25	2	4½	4½	1	4	60 x 38		
Ranger			20		20	1	6	1	1	4½	42	1 *a* 52	21 2
Lotus			16		16	1	4	1	1	2½	22		
Harry Lynds			20		20	1	7	1	1	7	30	1 *a* 13	12 3
Castalia	6	12	22	7	15	2	10	4	1	20	42	6	2-10 4- 6
Josie L. K			30		30	2	6	1	1	6½	42	*a* 52	2½
Little Maud						2	10½	3	1	24	40		
Minnehaha			40		40	1	4	1	1	6	24	*a* 31	2
Queen No. 2						1	8	1	1	8	36		
Mike Bauer			25		25	2	7	2	1	8	60	1	28
South Dacota	8	16	27	12	15	2	10	4	1	20	44	6	2-12 4- 7

a Tubes. *b* Sunk August 22, 1899. *c* First cabin. *d* Second cabin.

TABLE 4.—*List of steamers plying on the Missouri River in t during the year 1899*—Continued.

Name.	Boilers.			Licensed to run on—
	Iron or steel.	When built.	Steam pressure allowed.	
			Lbs.	
A. W. Ewing	Steel	1885	125	Mississippi and tributary rivers.
C. H. Hugo	do	1897	146	do
Columbia	do	1887	112	do
Commodore	do	1890	153	do
Dauntless	Iron pipe	1898	200	do
Fawn	Iron	1877	110	do
Frederick	do	1883	150	do
Gasconade	Steel	1891	160	do
Gus. Fowler a	do	1880	160	do
Golden Gate	Iron	1878	117	do
J. R. Wells	Steel	1898	177	do
J. W. Spencer	do	1882	150	Missouri River, 4 miles above and below St. Joseph.
Jack Rabbit	do	1889	130	Missouri and Gasconade rivers, New Haven to Boonville.
Jacob Richtman	do	1898	188	Mississippi and tributary rivers.
John R. Hugo	do	1894	160	do
Millboy	do	1893	110	do
Moline	do	1880	173	do
Peerless	do	1893	160	do
Thomas Parker	do	1887	146	do
New Haven		1892		do
Annie Cade	Iron	1879	114	Missouri River, 5 miles above and below Kansas City.
Ariel	Steel	1887	134	Missouri River, Lexington and opposite shore.
Carrie Cole	do	1898	180	Mississippi and tributary rivers.
Geo. W. Parker	Iron	1879	136	Missouri River, Kansas City to St. Joseph.
Jos. L. Stevens	Steel	1887	125	Missouri River, Boonville and opposite shore.
Lois	do	1896	110	Missouri River, 60 miles above and below Waverly.
Nadine	do	1889	130	Mississippi and tributary rivers.
Navajo	Iron pipe	1897	150	Missouri and Kaw rivers 100 miles.
Ranger	Steel	1897	120	Osage River, daylight only.
Lotus	Iron and steel.	1888	115	Missouri River, 50 miles above and below Brunswick.
Harry Lynds	Steel	1895	160	Missouri River, 100 miles above and below White Cloud.
Castalia	do	1892	160	Mississippi and tributary rivers.
Josie L. K	do	1888	120	Missouri and tributary rivers.
Little Maud	do	1889	140	Missouri River, Running Water, and Fort Randall.

a Sunk August 22, 1899.

TABLE 4.—*List of steamers plying on the Missouri River in the district of New Orleans during the year 1899*—Continued.

Name.	Boilers.			Licensed to run on—	Name and address of sole or managing owner.
	Iron or steel.	When built.	Steam pressure allowed.		
			Lbs.		
Minnehaha	do	1894	140	Big Sioux River	J. W. Clarridge, Sioux City, Iowa.
Queen No. 2	do	1898	150	Missouri River, Decatur and opposite shore.	Anderson & Kilbourn, Decatur, Nebr.
Mike Bauer	do	1899	150	Missouri River, Omaha to St. Joseph.	Mike Bauer, Nebraska City, Nebr.
South Dacota	do	1898	178	Missouri River, Omaha to Bismarck.	Jos. Leach, Running Water, S. Dak.

Very respectfully, your obedient servant,

A. H. BLAISDELL,
Assistant Engineer.

Capt. CHARLES KELLER,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., June 30, 1900.

CAPTAIN: I have the honor to submit the following report on the commerce of the Osage River during the calendar year 1899:

The steamboat traffic was performed principally by the steamers *Frederick* and *J. R. Wells.*

The total number of trips made by both steamers was 123, of which 6 were to Linn Creek, 110 miles; 16 to Tuscumbia, 60 miles; 21 to St. Elizabeth, 45 miles; 19 to St. Thomas, 35 miles, and the remainder from 25 to 7 miles.

The small steamer *Dauntless* was built for the trade between Tuscumbia and Linn Creek, and until disabled by accident early in the season made a few trips between those points.

The little steamer *Ranger* did a small amount of business in the vicinity of Papinsville, 282 miles above the mouth.

The freights of the *Frederick* were mostly delivered to the Missouri Pacific Railway at the mouth of the river, and those of the *Wells* to the Missouri, Kansas and Texas Railroad at Portland, on the left bank of the Missouri River, 22 miles below the mouth of the Osage.

The following table, giving the amount of freight carried, towed, and rafted, is a close approximation to the amount of the 1899 commerce of the Osage River:

TABLE 1.

Class.	Grain.	Live stock.	Wood and lumber.	Railroad ties.	Sand and gravel.	Salt.	Produce.	General merchandise, farm machinery, etc.	Total.	Mile-tons.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	
Packets and miscellaneous boats	4,077	873	2,115	214	9,945	371	165	3,608	21,368	393,136
Rafts, etc	.....	.....	3,809	51,525	.....	.....	.....	.....	55,334	2,968,121
Total	4,077	873	5,924	51,739	9,945	371	165	3,608	76,702	3,361,257

In these totals are included the following shipments on account of construction of Lock and Dam No. 1: 3,872 tons of piling and lumber, 920 tons of cement, and 2,289 tons of miscellaneous material, a total of 7,081 tons and 204,952 mile-tons.

Table 2 is a comparative statement of the commerce of the rive for the series of years 1899–1892:

TABLE 2.

Shipments.	1899.	1898.	1897.	1896.	1895.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Grain, hay, etc	4,077	3,418	1,598	2,651	4,496
Live stock	873	1,038	909	843	1,366
Lumber, logs, wood, railroad ties	57,663	74,881	66,175	62,764	64,986
Sand and gravel	9,945	3,015	1,350	4,500	3,600
Salt	371	348	229	416	328
Produce	165	201	255	188	191
General merchandise, farm machinery, etc	3,608	1,385	731	1,031	1,739
Barytes					
Total	76,702	84,286	71,247	72,393	76,706

Table 3 gives the comparative commerce of the river, expresse ing the series of years 1899–1894.

TABLE 3.

Class.	1899.	1898.	1897.	1896.
	Mile-tons.	*Mile-tons.*	*Mile-tons.*	*Mile-to*
Packets and miscellaneous boats	393,136	349,955	178,695	212,3
Rafts, etc	2,968,121	3,825,099	3,707,200	3,839,4
Total	3,361,257	4,175,054	3,885,895	4,051,8

Very respectfully, your obedient servant,

A. H. BLAISDELL,

Capt. CHARLES KELLER,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

MISSOURI RIVE
St. Louis, M

CAPTAIN: I have the honor to submit the following report o the Gasconade River during the calendar year 1899:

The steamboat traffic was entirely confined to two boats of the Packet Company.

About 60 per cent of the trade was over the lower 40 miles o round trips were made to Vienna, 79 miles above the mouth.

The average distance the railroad ties were rafted was 55 miles

The lumber reported and a portion of the ties were rafted ou which enters the Gasconade 122 miles above the mouth.

The following table, giving the amount of freight carried, to close approximation to the amount of the 1899 commerce of the

TABLE 1.

Class.	Grain.	Live stock.	Wood and lumber.	Railroad ties.	Building material.	Salt.	Produce.	Ge m cha fi ma ery
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	T
Packets, etc	2,100	414	451		6	33	85	
Rafts			75	19,338				
Total	2,100	414	526	19,338	6	33	85	

The following table gives the totals in classes of freight shipped during the series of years 1899–1892:

TABLE 2.

Shipments.	1899.	1898.	1897.	1896.	1895.	1894.	1893.	1892.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Grain, hay, etc	2,100	1,667	1,467	3,197	3,208	3,061	3,081	1,547
Live stock	414	708	686	1,131	920	847	144	416
Lumber, logs, wood, railroad ties	19,864	27,134	27,614	40,350	42,436	27,269	17,915	10,626
Sand and gravel	.....	163	15	102	.....	113	.....	.....
General merchandise, farm machinery, etc	1,757	872	480	896	780	1,016	703	287
Salt	33	57	85	96	83	69	80	23
Produce	85	223	114	131	122	136	135	80
Building materials	6	157	54	391	.....	.....	.....	.....
Total	24,259	30,981	30,515	46,294	47,544	32,511	22,058	12,929

The following table gives the comparative commerce of the river, expressed in mile-tons, during the six years 1899–1894:

TABLE 3.

Class.	1899.	1898.	1897.	1896.	1895.	1894.
	Mile-tons.	*Mile-tons.*	*Mile-tons.*	*Mile-tons.*	*Mile-tons.*	*Mile-tons.*
Packets and miscellaneous boats	307,376	162,594	179,777	229,215	197,574	211,353
Rafts	1,079,753	1,669,669	2,030,125	3,293,060	3,247,507	2,219,606
Total	1,387,129	1,832,263	2,209,902	3,522,275	3,445,081	2,430,959

Very respectfully, your obedient servant,

A. H. BLAISDELL, *Assistant Engineer.*

Capt. CHARLES KELLER,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

APPENDIX C.

ANNUAL REPORT ON OMAHA DIVISION, BY MR. S. WATERS FOX, DIVISION ENGINEER.

MISSOURI RIVER COMMISSION,
Jefferson City Mo., June 30, 1900.

COLONEL: I have the honor to submit the following annual report for the fiscal year ending June 30, 1900, of operations on Omaha division of the Missouri River.

The following illustrations accompany:

A map (Pl. I) of Missouri River in the vicinity of Omaha, Nebr., showing location and character of improvement works proposed and completed, and the extent of bank caving in the reach since 1896.

Two photographic views (Pls. II and III) of pile dikes below Pigeon Creek, built during the year.

A map (Pl. IV) of Missouri River, in vicinity of Nebraska City, Nebr., showing new curved end of Dike No. 5, built during the fiscal year of 1900, and the conditions of flow as they existed June 8.

A plan (Pl. V) of Dike No. 5, showing new curved end as built during the year.

Two photographic views (Pls. VI and VII) of Dike No. 5.

A map (Pl. VIII) of Missouri River, in vicinity of St. Joseph, Mo., showing revetment construction during the fall of 1899, and the extent of bank caving in the bend below the bridge since 1879.

Operations comprised revetment and dike construction at Omaha, restoration and repair of dikes at Nebraska City, revetment construction and repair at St. Joseph, surveys and examinations, care and repair of plant, and miscellaneous incidental work.

The total expenditure during the year was $80,219.06, as shown in the Appendix, Exhibit A.

OMAHA REACH.

[See accompanying map (Pl. I).]

Project.—The revised project, approved January 12, for the exp
allotted from the appropriation for the Missouri River in the
March 3, 1899, contemplated the construction of a revetment abou
and two dikes aggregating 1,000 feet in length at the shoulder of
the mouth of Pigeon Creek; a revetment of 1,000 feet in length,
500 feet in length on the right bank at Florence Lake; and a rev
feet in length at the head of the existing revetment on the left
Bluffs.

In February the Illinois Central Railway Company constructed
fairly good revetment at the head of the old revetment above Co
the gap which existed at the time the above project was made, s
ent, at least, no further work is needed there.

The interval between January 16, the date of receipt of notifica
project, and April 20, when construction work was commence
assembling plrnt, constrnction materials and supplies.

Revetment construction above Pigeon Creek.—The construction of
linear feet of revetment on the left bank above Pigeon Creek wa
20 and completed June 1. Standard specifications were closely
that the upper bank was graded to a much flatter slope than the
varied from 1 on 2 to 1 on 8, the average being about 1 on 4½.
advisable on account of the location of the revetment, which is su
exposed tomost violent attacks, in flood as well as in ice moveme
ment of the flow upon the bank there was so strong, in a nearly no
outside pile anchorage was necessary for the successful sinking o
the usual system of ⅞-inch strand was reenforced somewhat on
elements of work and cost are shown in the Appendix, Exhibit

Pile-dike construction.—As originally planned, the upper one of
proposed near Pigeon Creek was to be 300 feet long and the low
They were to be built on lines making angles of about 30° upstre
to the trend of the bank at their shore ends.

Owing to their exposed locations, the dikes were specially des
strain. Both were to be 3-row work, with 10-foot spacing; the
25 feet penetration in the upper row and 20 feet on the lower ro
bents to be formed of three clusters and the next nine bents insh
with an extra pile, driven immediately below the upper-row pil
usual head cluster of three piles to be driven above the outer two
to be in accordance with standard specifications, with double syst
of each dike; the foot mattress to be regular, but suspended to th
row at an elevation of 5 feet below S.L.W.; the piling and lumb
yellow pine, both dikes to be built to grades sloping from top of
to S.H.W., 100 feet inshore from stream end, and from there drop
S.H.W. at stream end; the bank at the shore end of each dike to
above the upper row and 10 feet below the lower row of dike t
in accordance with standard specifications, except that that port
extending upstream beyond the limits of the dike mattress be 40

The field estimates of cost, based upon the foregoing specificatio
rials, prepared from actual depths on lines of proposed dikes were
found necessary to shorten the upper dike to a length of 250 feet
to 550 feet.

Pending the arrival of the piling there was a general increase o
the vicinity of the dikes—that at the time of commencing operati
much as 21 feet on the line of the upper dike—so that the pili
structure were too short for use by just the amount of scour. In t
siderable item of increase in cost of the structure was incurred.
largely to other items of expense imposed by the unusually sever
during the period of construction work, arising from abnormally
several sudden, sharp rises, with heavy flows of driftwood, tha
dikes greatly exceeded the estimates.

The attacks to which these structures were subjected was so
times their loss seemed imminent.

Upper dike near Pigeon Creek.—The construction of this dike
May 1 and completed May 21. The following work was accompl
25 piles driven for temporary anchorage; of these, 2 clusters of
scoured out and replaced with 4 clusters of 3 and 1 pair, the ne
being obtained by splicing piles to lengths of 60 and 62 feet.

95 piles driven in dike.
250 linear feet of dike braced.
304 linear feet = 25,537 square feet of foot mattress woven and ballasted.
135 linear feet of curtain attached from shore end.
165 linear feet of shore protection at root of dike constructed.

During a 2-foot rise on the 22d of May, which crested at 6 feet above S. L. W. on the 24th, large quantities of drift accumulated on the dike and its anchor piles. The flow chorded the bay above and impinged against the dike with great force, being accentuated by a bold reef that formed immediately opposite and close to the foot of the Pigeon Creek revetment. Scour took place all along the dike, but particularly on the outer 50 feet, leaving the piles with very slight penetration, and it is probable that had it not been for the support afforded by the suspended mattress and bracing the entire structure would have gone out.

Strand ties were run out at intervals on the dike, leading well upstream, made taut by capstan, and secured to dead men on shore, but notwithstanding these measures bents 7 to 13 were forced downstream some 3 feet out of line, and on the 25th the outer 5 bents gave way and swung downstream with the current under a suddenly increased strain imposed by a mass of drift which was released by the breaking of the temporary anchor piles above. On May 26 the 5 bents with their bracing broke loose and lodged against the lower dike between bents 35 and 40, breaking 2 anchorage piles on their way.

On May 28 about 107 tons of extra stone ballast were placed around the outer end of the dike.

An effort was made to sink the drift above the dike with stone, but it was abandoned on account of excessive cost after expending about 10 tons of stone.

Between June 1 and 4 the outer end of the dike was reenforced with some heavy fascine work; 25 fascines, 4 feet in diameter by 25 feet long, were placed on the lower side of the dike from bents 17 to 19. The depth of water at the time the fascines were thrown in was 45 feet. On completion of the work the top fascines were at a depth about 18 feet below S. L. W. Soundings taken on June 15 indicated a settlement of 9 feet.

Lower dike near Pigeon Creek.—The construction of this dike was commenced May 3, and when operations were suspended, June 1, it had been completed from the shore to bent No. 44.

The pile driving for the entire length of dike, 550 feet, was accomplished in accordance with the plans between May 4 and 23, 191 piles being driven in the dike and 24 for temporary anchorage. Before the completion of this branch of the work, some of the piles had been lost from scour and drift. On May 25 an attempt was made to replace the lost piles, but it was found that the bottom had scoured to such a depth that the longest piles in stock would, if driven, have a penetration of only about 10 feet. Pile driving was therefore suspended.

On May 26 and 27, during a slight rise, another run of drift, together with the wreckage of a part of the upper dike, lodged against the lower one. The foot mattress commenced May 14 had been woven to bent 46, where it had to be dropped on account of the driftwood. It was sunk in good shape and completely ballasted. The mattress was 461 feet long and contained 34,865 square feet.

The bracing was completed to bent 44, and the curtain was attached for 390 feet from the shore.

The shore protection at the root of the dike, 130 feet in length, was completed.

As a result of the rise of May 26 and 27, above referred to, there was a scour all along the dike, and its loss seemed imminent. The weakest portion appeared to be from bent 33 to 44, where the tops of the piles were swung downstream. This portion of the dike was reenforced by driving 26 additional piles below the injured bents and connecting them with the usual bracing.

Beyond bent 44 (the outer 100 feet of the dike) the piles had not been braced, and some of them were scoured out and many bent over.

No effort was made to restore this part of the structure. The elements of work and cost of the two dikes are shown in the appendix, Exhibit C.

Revetment construction at Florence Lake.—All of the materials required for the construction of the revetment authorized on right bank at Florence Lake had been secured, and on May 26 a small force was engaged in clearing the bank of undergrowth.

On May 31 a hydraulic grader was placed in position at the head of the proposed work and was employed for a few hours in grading, when instructions were given for a suspension of work. The conditions at the time were such that the successful completion of the revetment, with the funds then available, was very doubtful.

Subsequent developments verified the wisdom of this course, as the rapid bank caving and immense quantities of drift attending the several sharp rises in the river would have made its construction very difficult and expensive.

The cost of this construction work was $43.59.

An examination of the dikes near Pigeon Creek on June 24 di
ing conditions: The upper dike was in good condition from the sh
the line of swiftest flow had moved out, leaving the structure i
the right-shore bar line, for a mile above the dike, showed eviden
and there were indications that the line of main flow was wel
shore; this change had subjected the lower dike to a severe attac
of that structure being exposed to a very swift current, which r
scour; bent No. 44, including the reinforce piles and five of the p
42, had been washed out.

The revetment above Pigeon Creek appeared to be in good co
about 45 feet of the subaqueous work at the lower end had bee
action.

NEBRASKA CITY REACH.

[See accompanying map (Pl. IX).]

Project.—Under date of September 16, I was notified of the appr
project for the expenditure of $16,000, allotted for local works
Mo., from the appropriation for Missouri River in the river and h
3, 1899. The project provided for the expenditure of as much as
for restoring the curved end of dike No. 5, near Nebraska City, Ne
cost was $12,600. The original plan of work for the restoration o
the dike was received with your letter of August 19. Several autho
of plan, to meet exigencies of the work and indicated by further stu
were made, resulting finally in a structure, the plan of which is sh
panying plate (Pl. X).

It is composed of six rows of piles, braced, provided with foot mat
the piles are driven on the arcs of concentric circles; commenci
and designating them for convenience of reference by the letter
the rows are spaced as follows: A to B, 10 feet; B to C, 15 feet; C t
10 feet, and E to F, 15 feet. The radius of the A row is 800 feet.
at the lower end of the work to the approved line of rectification
the upper pile of the 44th bent of the old main dike; the A row te
80 feet on the curve above the latter and 660 feet above its lower
gency subtending a central angle of 47° 15′ 48″; the piles in the A
feet centers; those in B, E, and F rows fall on radial lines throu
the piles in the C and D rows are placed only on every fourth r
lower end, where the work across the berm is 2-row; the grade o
is S. H. W., that of the others 5.66 feet lower, forming a flat berm
feet above S. L. W.; it was intended that the foot mattress below
should be 155 feet wide throughout, extending 15 feet inside of
outside of the A row, and 25 feet below the lower end radial be
the extent of foot mattress as built is shown in the plan; below b
was suspended from the piles in the F row at S. L. W., and heavi
of the A row; the bracing consists of single sticks of 6 by 8 inc
screw bolted on upper and outer faces of piles; the piling is long-
and F rows and the single rows of piles on fourth radials are cu
the lower row of the old main dike; ten bents of 2-row pile w
provided with foot mattress and curtain, built to level grade S. H
85, extending 108 feet inshore from F row.

Preliminary measures were taken in August, on receipt of the
for assembling plant and construction materials, but it was not
that construction work was commenced.

At that time all of the construction materials had arrived, or w
in sufficient quantities to meet the requirements of the work, exc

The work was soon well in hand, and had the piling been de
could easily have been completed before the first run of ice, at
estimates.

As it was, however, the delivery of piling was not completed
and meanwhile, on December 4, a sudden fall in temperature pr
which compelled a suspension of operations, with the work in
construction. Thereafter, until final suspension in April, the w
under many difficulties and at great expense.

On the night of December 4 the mattress, which had been w
radial bent No. 60, and was still afloat, was overrun by a heavy fl
pulled from the mattress boat outside of the A row.

Continued cold weather made it impracticable to carry on wo

row, but on December 8 work inside of that row was resumed, and the mattress completed in ten days thereafter to a radial line 25 feet below the end bent of pile work.

When operations were suspended for the winter, on December 22, all of the piles in the new curved end had been driven and braced to grades, excepting those in the A and B rows above the main dike and the inside radial 2-row work on radial No. 85.

The foot mattress that had been woven up to that time was properly sunk and ballasted as follows: Above the main dike, from bent 29 to 44, 131 tons of stone were expended; below the main dike, from bent 32 to 44, 15 tons; from bent 44 to bent 60, outside of the A row, 60 tons; between A and C rows, from bent 65 to 101, 130 tons; making a total of 336 tons of stone expended on mattress.

The only curtaining done up to this time was that on the lower row of the old main dike, from bent 29 to bent 44.

Resuming operations on March 12, the A and B row work was extended above the main dike and the pile work in the dike beyond the line of the E row cut down to the berm grade of 3 feet above S. L. W.

The inner radial 2-row dike on radial No. 85 was built, and after several interruptions on account of sharp rises in the river, the foot mattress outside of the A row was extended downstream in two pieces, as shown on the plan to radial bent No. 89, and ballasted.

In ballasting the foot mattress on the inside radial dike, 35 tons of stone were used and 246 tons were expended on the lower two pieces of mattress outside of the A row.

The curtaining of the structure was completed March 22, in accordance with the plans, excepting that on the A row, where the depths and current were too great for satisfactory work.

On April 1, while the middle piece of mattress, outside of the A row, was in process of construction, a sharp rise of nearly 2 feet, carrying heavy driftwood, ruptured the mattress near radial bent No. 67, setting adrift the mattress boat with about 150 linear feet of mattress attached to it, and a 100-foot barge. Six of the inside anchor piles and one of the outside anchor clusters were broken off. The boat and barge were recovered below the bridge; the mattress was lost.

The funds at this time were so nearly exhausted that it became necessary to reduce the width of the lower piece of mattress. It was made 60 feet wide at its head, on radial No. 66, carried that width to bent No. 71, and narrowed to 45 feet at bent 77. The latter width was preserved to the end of the mat, on radial No. 89, where it had to be dropped April 7 and ballasted on account of another quick rise of about 2.5 feet.

By a modification of plan after construction materials had been acquired, the length of the new curved head was shortened to such an extent that a surplus of materials to the value of $1,792.60 was created.

A transfer of these materials to the Omaha work was authorized and covered by the transfer of funds in that amount from the Omaha allotment to that for local works above Kansas City.

The elements of work and cost of the new curved end of Dike No. 5 are shown in the appendix, Exhibit D.

Dike repairs, Dike No. 1.—After the ice movement of March 10 the left bank above Dike No. 1 was severely attacked, causing it to cave rapidly at the root of the structure and for 500 feet upstream.

By March 20 a portion of the dike curtain and the shore protection above it had been destroyed.

An effort was made to check the caving at the dike by renewing its curtain, but it was ineffectual, and, on April 14, the structure was flanked. An opening about 75 feet wide soon formed, and the flow through it threatened the dikes below.

Dike repairs, Dike No. 2.—In order to prevent the flanking of this structure you verbally authorized the construction of a shore spur at its root.

The work was accomplished between the dates of April 21 and 25. Eighteen fascines, 4 feet in diameter and 25 feet long, were placed, forming a spur, the lower side of which was about on range from bent No. 1 of Dike No. 2 to the fourth bent from the stream end of Dike No. 1.

It appeared that the spur had the desired effect. There was no caving after its completion.

Dike repairs, Dike No. 3.—Between the dates of April 22 and 25 a depression at the shore end of this dike, probably caused by eddy action during a flood, was filled back to the dike grade with brush and heavily ballasted with stone.

The cost of the above repairs on Dikes No. 1, 2, and 3 was $380.62.

Damages to work and present conditions.—For some months past the line of principal flow has chorded Copeland Bend above Nebraska City. This has favored a lower

TABLE 4.—*List of steamers plying on the Missouri River in the district during the year 1899.*

Name.	Where built.	Year.	Where enrolled.	Dimen	
				Length.	Breadth.
				Feet.	*Fee*
A. W. Ewing	Osage City, Mo	1878	St. Louis, Mo		
C. H. Hugo	New Haven, Mo	1897	do	79.2	18.
Columbia	Osage, Mo	1898	do	80.5	18.
Commodore	New Haven, Mo	1890	do	97	23.
Dauntless	Tuscumbia, Mo	1898	do	59.3	11.
Fawn	Hermann, Mo	1880	do	91.9	19.
Frederick	Tuscumbia, Mo	1883	do	96.4	14.
Gasconade	L'Outre Island, Mo	1891	do	107.4	23.
Gus. Fowler b	Jeffersonville, Ind	1880	do	160	29.
Golden Gate	St. Louis, Mo	1878	do	131.4	30.
J. R. Wells	Tuscumbia, Mo	1898	do	110.6	20.
J. W. Spencer	Jeffersonville, Ind	1882	do	131	35.
Jack Rabbit	Mount Sterling, Mo	1897	do	73.6	16.
Jacob Richtman	Sterling Island, Mo	1898	do	160	32.
John R. Hugo	Evansville, Ind	1879	do	127	20.
Millboy	Hermann, Mo	1893	do	89.2	18.
Moline	Rock Island, Ill	1880	do	126.2	26.
Peerless	Hermann, Mo	1893	do	96.6	21.
Thomas Parker	St. Louis, Mo	1894	do	100	18.
New Haven	Pomeroy, Ohio	1892	do	101	20
Annie Cade	Leavenworth, Kans	1879	Kansas City, Mo	127.5	32
Ariel	Lexington, Mo	1897	do	84.6	21
Carrie Cole	Chicago, Ill	1887	do		
Geo. W. Parker	Pittsburg, Pa	1879	do	266	46.
Jos. L. Stevens	Jeffersonville, Ind	1887	do	103	29.
Lois	Waverly, Mo	1896	do	75.2	18.
Nadine	Lamine, Mo	1892	do	75.3	15.
Navajo	Kansas City, Kans	1897	do	38.5	4.
Ranger	Papinsville, Mo	1898	do	36.2	8.
Lotus	Burlington, Iowa	1888	do		
Harry Lynds	White Cloud, Kans	1892	St. Joseph, Mo	64	18
Castalia	Sioux City, Iowa	1892	Omaha, Nebr	110	26.
Josie L. K	Chamberlain, S. Dak	1896	do	60	14
Little Maud	Sioux City, Iowa	1882	do	92	20
Minnehaha	Canton, S. Dak	1898	do		
Queen No. 2	Tierville, Iowa	1879	do	44	12
Mike Bauer	Brunswick, Mo	1892	do	65	9.
South Dacota	Running Water, S. Dak	1899	do	137.5	19.

a Estimated.

b Sunk August 22, 1899.

TABLE 4.—*List of steamers plying on the Missouri River in the district of New Orleans during the year 1899*—Continued.

Name.	Staterooms.	Berths.	Passengers.			Engines.			Boilers.				
												Flues.	
			Permitted to carry.	First cabin.	Steerage or deck.	Number.	Diameter.	Stroke.	Number.	Length.	Diameter.	Number.	Diameter.
							In.	*Feet.*		*Feet.*	*Inches.*		*Inches.*
A. W. Ewing	....	....	8	.....	8	1	6	3	1	3	40	*a* 70	1½
C. H. Hugo	....	....	20	.....	20	2	7	3	1	13½	50	1	28
Columbia	....	....	10	.....	10	2	7½	2½	1	11½	34	*a* 28	3
Commodore	....	....	50	.....	50	2	10	4	1	20	44	6	2-12 4- 6
Dauntless	....	....	19	.....	19	2	5½	2	1	5	48 x 54	.....	.....
Fawn	....	....	50	.....	50	2	8	2	1	14	42	4	2-10 2-12
Frederick	4	13	28	13	15	2	7	2½	1	14	36	6	6
Gasconade	3	6	35	5	30	2	9	3½	1	20	42	6	2-10 4- 6
Gus. Fowler *b*	25	56	121	*c* 56 *d* 15	50	2	14½	4	2	28	42	5	10
Golden Gate	8	16	66	16	50	2	16	4	2	28	40	2	14
J. R. Wells	5	10	20	10	10	2	10	4	1	18	44	10	6
J. W. Spencer	....	....	.....	.....	.....	2	16	6	2	26	40	.....	.....
Jack Rabbit	....	....	20	.....	20	2	6	2	1	10	36	*a* 14	9-3 5-3½
Jacob Richtman	13	26	126	26	100	2	14	6	2	22½	44	34	3½
John R. Hugo	6	10	25	9	16	2	12½	3½	1	24	42	5	10
Millboy	....	....	20	.....	20	2	8	3	1	14	44	1 *a* 26	24 3
Moline	6	12	25	.....	.....	2	14	5	2	24	40	12	8
Peerless	2	4	22	.....	22	2	8	3	1	16	42	2 *a* 6	15 3
Thomas Parker	5	10	20	5	15	2	10	6	1	20	46	6	2-13 4- 7
New Haven	....	....	.....	.....	.....	2	10½	3	2	20	36	4	12
Annie Cade	....	....	.....	.....	.....	1	20½	5½	2	16	42	.....	.....
Ariel	....	....	.....	.....	.....	2	9	3	1	18	42	.....	.....
Carrie Cole	....	....	16	.....	16	1	4½	1	1	4½	30	.....	.....
Geo. W. Parker	....	....	.....	.....	.....	2	22	7	4	26	42	.....	.....
Jos. L. Stevens	....	....	.....	.....	.....	2	10	3½	1	16	48	.....	.....
Lois	....	....	21	.....	21	2	7	2½	1	12	40	.....	.....
Nadine	....	....	20	.....	20	2	8	2	1	14	40	*a* 39	3
Navajo	....	....	25	.....	25	2	4½	4½	1	4	60 x 38	.....	.....
Ranger	....	....	20	.....	20	1	6	1	1	4½	42	1 *a* 52	21 2
Lotus	....	....	16	.....	16	1	4	1	1	2½	22	.....	.....
Harry Lynds	....	....	20	.....	20	1	7	1	1	7	30	1 *a* 18	12 3
Castalia	6	12	22	7	15	2	10	4	1	20	42	6	2-10 4- 6
Josie L. K	....	....	30	.....	30	2	6	1	1	6½	42	*a* 52	2½
Little Maud	....	....	.....	.....	.....	2	10½	3	1	24	40	.....	.....
Minnehaha	....	....	40	.....	40	1	4	1	1	6	24	*a* 31	2
Queen No. 2	....	....	.....	.....	.....	1	8	1	1	8	36	.....	.....
Mike Bauer	....	....	25	.....	25	2	7	2½	1	8	60	1	28
South Dacota	8	16	27	12	15	2	10	4	1	20	44	6	2-12 4- 7

a Tubes. *b* Sunk August 22, 1899. *c* First cabin. *d* Second cabin.

October 4 to 8 a shore-line survey was made from Boyer Creek to a point 1 mile below the Chicago and Northwestern Railway dikes above Council Bluffs, Iowa. This was in part resurveyed in January, May, and June.

Between the dates of May 14 and 16 8 cross sections were sounded and float paths located in the vicinity of the Omaha Bridge and Terminal Railway Company's bridge at Omaha, Nebr., to determine the conditions of flow in the approaches to the draw-span. A hydrographic survey of the reach from Arago, Nebr., to Rulo, Nebr., was commenced June 26 and is now in progress.

Between the dates of June 26 and 29 an examination of the river improvement works from above Atchison, Kans., to the Hannibal bridge at Kansas City, Mo., was made by Assistant Engineer Ed. Jones. A copy of his report was forwarded with my letter of June 30. In addition to the above, other survey work incidental to river improvement works was done.

The cost of survey work during the year was $807.44.

Very respectfully, your obedient servant,

S. WATERS FOX, *Division Engineer.*

Lieut. Col. AMOS STICKNEY,
Corps of Engineers, U. S. A., President Missouri River Commission.

LIST OF EXHIBITS FORMING APPENDIX TO FOREGOING REPORT.

A.—Classified statement of money expenditures during the fiscal year.

B.—Elements of work and cost in detail, 700 linear feet revetments, Pigeon Creek near Omaha, Nebr.

C.—Consolidated bill of cost of dike construction, Pigeon Creek dikes, near Omaha, Nebr.

D.—Elements of work and cost in detail of new curved head, Dike No. 5, Nebraska City Reach.

E.—Elements of work and cost in detail of 2,659 linear feet revetment, St. Joseph Reach.

EXHIBIT A.

Classified statement of money expenditures, under allotments for works on Omaha division during the fiscal year ending June 30, 1900.

Classification.	At Omaha and Council Bluffs.	Vicinity of St. Joseph, Mo.	At St. Joseph, Mo.	Opposite Leavenworth, Kans.	At mouth of Kaw River.	Local works above Kansas City, Mo., act of 1897.	Local works above Kansas City, Mo., act of 1899.	Total.
Actual expenditure on account of construction work for labor and materials	$24,716.53	.....	$16,996.30	$2.00	.....	$935.39	$13,553.35	$56,203.57
Tow-boat service while directly engaged in construction	1,472.66	.....	2,542.96	.....	.....	17.50	1,415.01	5,448.13
Total	26,189.19	.....	19,539.26	2.00	.....	952.89	14,968.36	a 61,651.70
All other plant service, including repairs, watching, and moving from place to place	5,132.19	$348.51	2,250.83	107.82	.....	.....	1,814.45	b 9,653.80
Administration charges Jefferson City office and field	4,615.09	.78	1,887.81	2.17	$113.35	.....	728.70	c 7,347.90
All other charges:								
New plant	309.24	111.75	212.76	.....	.....	.....	159.29	793.04
Surveys	520.66	.....	109.34	.....	.....	20.62	122.00	772.62
Total	829.90	111.75	322.10	109.99	113.35	20.62	281.29	d 1,789.66
Grand total	36,766.37	461.04	24,000.00	111.99	113.35	973.51	17,792.80	80,219.86

a About 77 per cent of grand total expenditures.
b About 12 per cent of grand total expenditures.
c About 9 per cent of grand total expenditures.
d About 2 per cent of grand total expenditures.

EXHIBIT B.

Elements of work and cost in detail of 700 linear feet of revetment, near Pigeon Creek, above Omaha, Nebr., constructed during April, May, and June, 1900.

Classification.	Cost in item.	Total.
Grading bank, 762 linear feet, containing 5,629 cubic yards of earth:		
Supplies	$31.59	
Labor and subsistence	161.11	
Total cost at $0.0342+ per cubic yard		$192.70
Construction and anchorage of mattress, 700 linear feet or 61,285 square feet:		
394 cords brush	426.19	
6,939 pounds ½-inch strand	461.44	
391 cable clips	70.38	
396 linear feet pine piling	84.53	
Supplies	2.34	
Labor and subsistence	608.02	
Total cost at $0.02697+ per square foot		1,652.90
Ballasting mattress and bank, 2,074 cubic yards:		
2,074 cubic yards stone	2,329.98	
Labor and subsistence	395.66	
Total cost at $1.314+ per cubic yard		2,725.64
Towage, moving construction parties, their plant and supplies		353.27
All other items incidental to construction		1,074.21
Grand total cost at $8.5696 per linear foot		5,998.72

EXHIBIT C.

Consolidated bill of cost of construction and reinforcement of Upper and Lower Pigeon Creek dikes, near Omaha, Nebr., during May and June, 1900.

Classification.	Designation.	Upper Pigeon Creek Dike.				Lower Pigeon Creek Dike.			
		Construction.		Reinforcing dike with fascine work, etc.		Construction.		Reinforcing dike with pile work.	
		Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
Pine piling	Linear feet	5,714	$1,220.49	26	$5.33	9,006	$1,978.43	.....	.....
Pine lumber	Feet B. M.	10,816	159.12	168	3.36	14,989	228.50	2,620	$48.75
Brush and poles	Cords	188	235.59	100	108.17	247.6	314.42	.....	.....
Stone	Tons	378.4	425.10	224.4	252.01	391.2	439.47	.....	.....
Strand, galvanized	Pounds	4,055	277.78	1,233	89.41	4,180	277.97	.....	.....
Bolts, spikes, nails, and clips.	.....	.....	140.22	.....	4.77	.....	165.59	.....	24.50
Supplies and fuel	.....	.....	25.98	.....	.....	.....	34.98	.....	3.98
Labor and subsistence, as follows:									
Pile driving	.....	.....	374.85	.....	.....	.....	353.64	.....	88.11
Bracing	.....	.....	185.03	.....	.....	.....	281.57	.....	68.10
Weaving and sinking.	.....	.....	394.94	.....	.....	.....	448.43	.....	.....
Curtaining	.....	.....	24.96	.....	.....	.....	54.04	.....	.....
Grading and paving bank.	.....	.....	61.14	.....	.....	.....	48.71	.....	.....
Building and placing fascines.	.....	.....	.....	.....	189.92	.....	.....	.....	.....
Pulling driftwood.	.....	.....	.....	.....	.....	.....	.....	.....	125.82
Inspecting and handling materials.	.....	.....	322.56	.....	127.74	.....	502.50	.....	5.76
Steamboat service, towing all supplies, etc., construction materials, moving parties and their plant.	.....	.....	438.96	.....	89.17	.....	584.59	.....	42.75
All other items incidental to construction.	.....	.....	220.26	.....	44.67	.....	293.82	.....	21.45
Total	.....	.....	4,506.98	.....	914.55	.....	6,006.16	.....	439.22

EXHIBIT D.

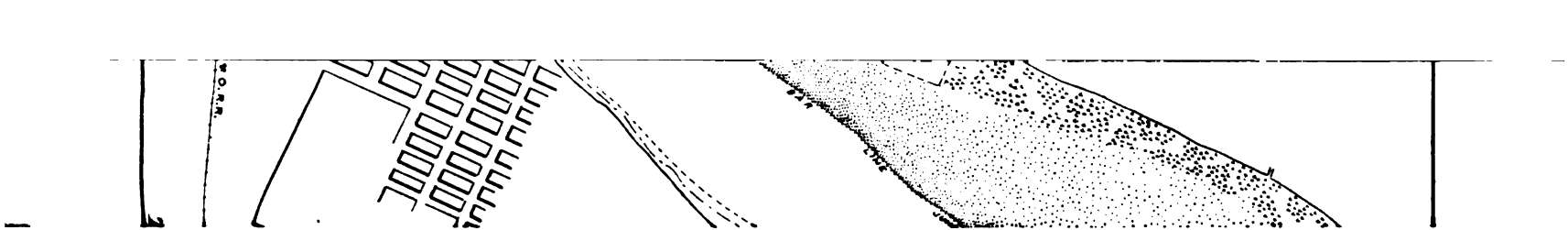
Elements of work and cost in detail of construction of new curved head, Dike No. 5, Nebraska City Reach, during the months November, 1899, to April, 1900.

Classification and extent.	Cost in item.	Total.
Pile work, 670 linear feet, 6-row:		
395 = 16,504 linear feet pine piling	$3,347.16	
Bolts, washers, and nails	4.80	
Supplies and fuel	84.26	
Labor and subsistence	1,064.22	
		$4,500.4
Bracing, 670 linear feet, 6-row:		
84,322 feet B. M. pine lumber	679.11	
Bolts, washers, and nails	207.67	
Labor and subsistence	612.90	
		1,499.6
Foot mattress, 116,779 square feet:		
796.5 cords brush and poles	1,551.58	
576 feet B. M. pine lumber (deadmen)	10.08	
19,565 pounds strand and wire	1,187.64	
Bolts, washers, nails, and cable clips	88.95	
Labor and subsistence	1,669.36	
		4,507.6
Ballasting mattress:		
617.7 tons stone	495.43	
Labor and subsistence	469.11	
		964.5
Curtaining 2,640 linear feet:		
98.75 cords poles	298.59	
481 pounds nails	16.84	
Labor and subsistence	376.96	
		692.3
Steamboat service, towing plant, construction material, and supplies		1,443.2
All other items incidental to construction		652.1
Total cost		14,260.3

EXHIBIT E.

Elements of work and cost in detail of 2,659 linear feet of revetment at St. Joseph, Mo., constructed during September, October, and November, 1899.

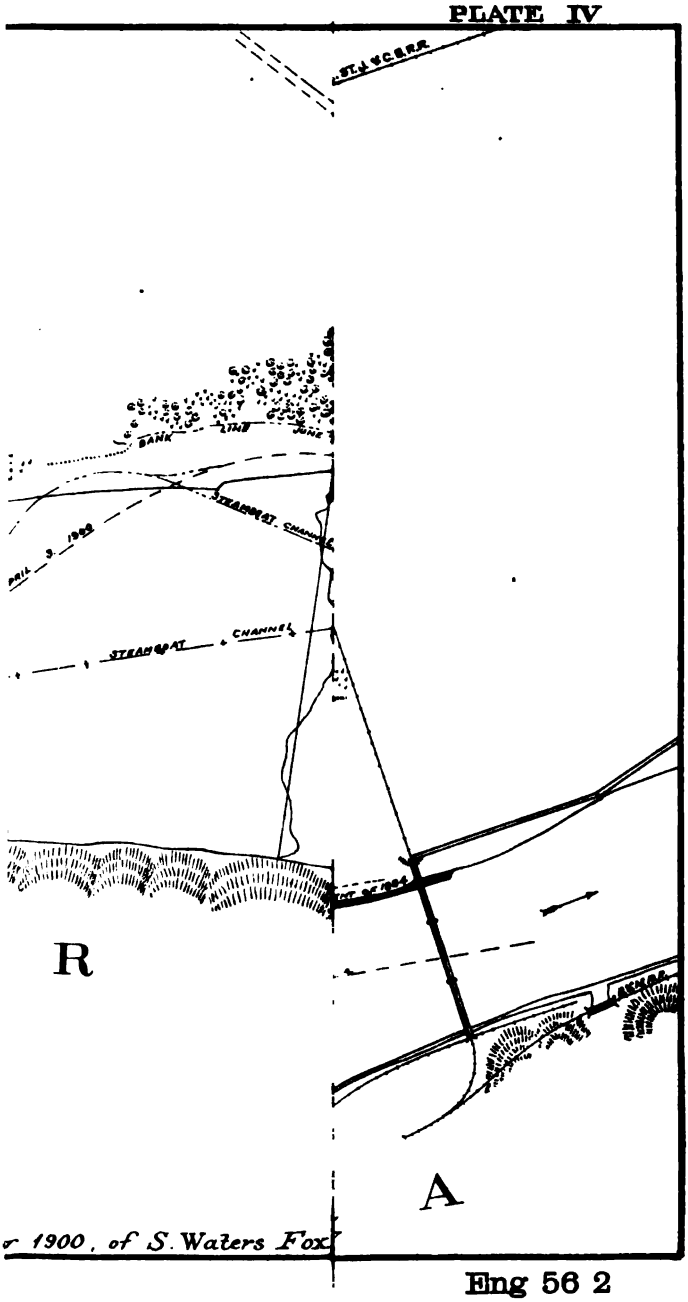
Classification and extent.	Cost in item.	Total.
Grading bank, 2,800 linear feet, containing 13,762 cubic yards of earth:		
Supplies	$156.73	
Labor and subsistence	464.09	
Total cost at $0.0451 per cubic yard		$620.82
Construction and anchorage of mattress, 2,714 linear feet or 235,335 square feet:		
1,379 cords brush	2,465.70	
20,829 pounds ¾-inch strand	1,176.27	
1,997 pounds cable clips	63.85	
640 linear feet pine piling (deadmen)	66.27	
Labor and subsistence	1,973.28	
Total cost at $0.0244 per square foot		5,745.37
Ballasting mattress and bank, 7,059.67 cubic yards:		
7,059.67 cubic yards stone	7,329.41	
Labor and subsistence	2,314.61	
Total cost at $1.366+ per cubic yard		9,644.02
Towage, moving construction parties, their plant, materials, and supplies		2,294.71
All other items incidental to construction		548.14
Grand total cost at $7.090+ per linear foot		18,853.06



OMAHA REACH. UPPER AND LOWER DIKES NEAR PIGEON CREEK. LOOKING DOWNSTREAM FROM LEFT BANK ABOVE UPPER DIKE. JUNE 22, 1900. STAGE, 5.7 FEET ABOVE S. L. W.

OMAHA REACH. LOWER DIKE NEAR PIGEON CREEK. LOOKING TOWARD OUTER END OF DIKE FROM BANK BELOW STRUCTURE. JUNE 14, 1900. STAGE, 5.3 ABOVE S. L. W.

PLATE IV



1900, of S. Waters Fox

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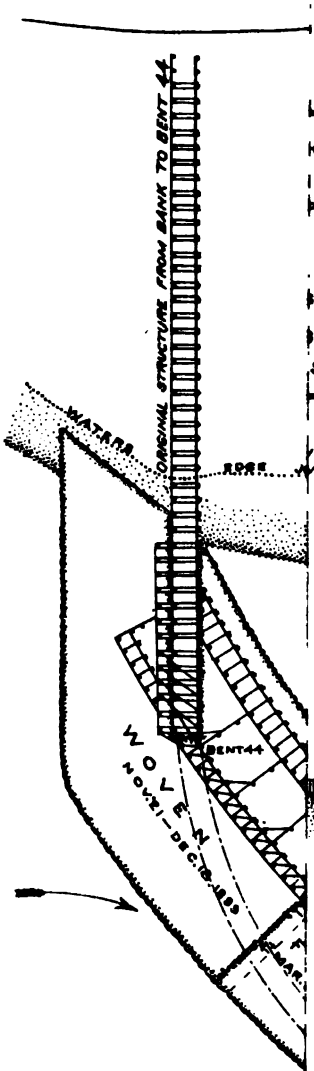
PLATE V



VER COMMISSION
HA DIVISION
I CITY REACH
PLAN
OF
NO. 5
SHOWING
BUILT DURING THE FISCAL YEAR
SCALE:
300 Ft.

NOTE:
GINAL CURVED END OF BIKE
VE 1899 INDICATED THUS

RADIAL BENT No. 85

rt for 1900.
st. Eng'r.

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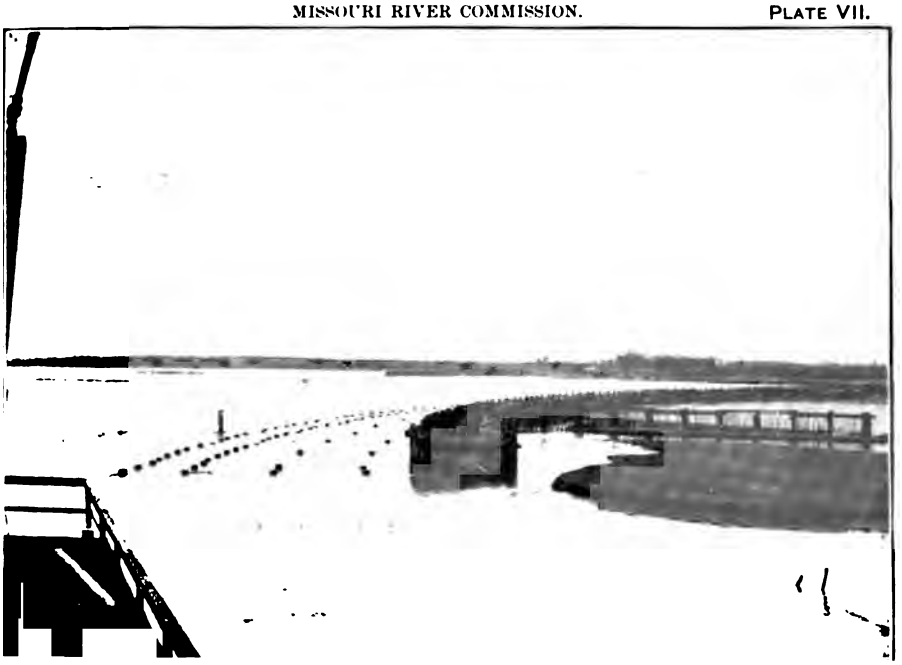
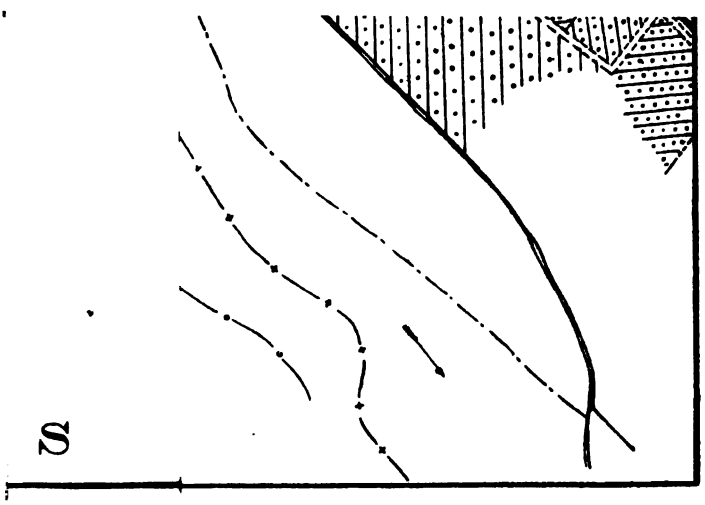
NEBRASKA CITY REACH. DIKE NO. 5, LOOKING DOWNSTREAM FROM UPPER ACCRETIONS. CONSTRUCTION PARTY DRIVING UPSTREAM EXTENSION OF NEW CURVED END OF PILE DIKE. MARCH 24, 1900. STAGE, 1 FOOT ABOVE S. L. W.





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APPENDIX D.

ANNUAL REPORT ON GASCONADE DIVISION, BY MR. S. WATERS FOX, DIVISION ENGINEER.

MISSOURI RIVER COMMISSION,
Jefferson City, Mo., June 30, 1900.

COLONEL: I have the honor to submit the following annual report for the fiscal year ending June 30, 1900, of the operations on the Gasconade division of the Missouri River.

The following illustrations accompany:

A map and some cross sections (Pl. I) of the river at Jefferson City, Mo., showing the locations and character of improvement works constructed during the fiscal year and previously and their effects upon the local conditions of the flow.

A map (Pl. VI) of the river in the vicinity of Chamois Bank-head.

Four photographic views (Pls. II to V) of some of the works.

Operations comprised revetment, dike, abatis, and hurdle construction, involved in a scheme of rectification opposite Jefferson City, Mo.; revetment repairs on Chamois reach; construction of new plant; care and repair of plant at the Gasconade boat and supply yard, and surveying.

WORKS OPPOSITE JEFFERSON CITY, MO.

[See accompanying map (Pl. I).]

The work was done in accordance with approved plans under an allotment of $16,000 from the appropriation for improving the Missouri River in the sundry civil act of March 3, 1899.

The total expenditure was $15,822.62, as shown in detail in the Appendix, Exhibit A.

Project.—The following is a copy of the project approved by the Chief of Engineers under date of July 27, 1899: "The act requires that the money be expended to compel the river to the right shore at Jefferson City, so as to cut out the existing shore bar in the bay below the bridge. The amount of funds available is not sufficient to fully accomplish that end, but as a necessary preliminary step, it is proposed to expend the money in the construction of some works (indicated on the map) that will close the chute to the north of the towhead, which lies opposite Jefferson City, and cause deposits which will advance the line of the shore bar above well out to the original approved line of rectification."

Later on, in October, 1899, you verbally authorized the construction of a line of abattis and hurdle work across the high-water chute at the end of the old pile Dike E.

Active operations were commenced August 24 and practically completed October 24, though the screening on abatis No. 1 was adjusted and reenforced to bring it back to grade after a slight settlement in November.

Abatis and hurdle construction.—The abatis work was built under the standard specifications, each structure being made continuous throughout its length.

The working plans of an abatis were published in my annual report for 1898 (Pl. IX). The accompanying photographic view (Pl. V) shows the method employed in building a continuous abatis over water.

The total length of abatis constructed was 3,080.6 feet, distributed as follows:

Abatis No. 1.—Length, 260 feet; grade line through top of screening poles sloped uniformly from 2 feet above S. H. W. at shore end to 2 feet above S. L. W. at stream end. Commenced October 7, completed October 17. Screening reenforced and raised to grade after settlement November 6 to 10.

Abatis No. 2.—Length, 547 feet; grade was carried out level at 2 feet above S. H. W. from shore end 145 feet and there dropped uniformly to 2 feet above S. L. W. at stream end. Commenced September 30, completed October 22.

Abatis No. 3.—Length, 1,026.6 feet, line of work carried out normal to flow to point 650 feet from shore and there bent downstream, making an angle of 152° 55′; grade sloped uniformly from 2 feet above S. H. W. at shore end to 6 feet above S. L. W. 650 feet out, and there dropped uniformly to 2 feet above at stream end. Commenced September 26, completed October 12.

Abatis No. 4, across chute.—Length, 1,122 feet; built to level grade 2 feet above S. H. W. Lower end of abatis rests on towhead revetment 100 feet above the chute end of that work and crosses the chute on line bearing N. 45° 40′ W. Commenced September 14, completed September 27.

Abatis and Hurdle E.—Length, 359.3 feet; composed of 125 linear feet of abatis, connected with the stream end of old pile Dike E at one end by 93 linear feet of hurdle and with the high ground at the other by 141.3 linear feet of hurdle. The hurdle work consists of three rows of posts, 4 to 6 inches diameter, driven to an average penetration of 5 feet, the rows spaced 8 feet and the posts 5 feet; the upper

two rows are dropped braced and the lower two wattled. A brush floor was laid throughout to provide against scour. Both abatis and hurdles were built to a level grade 2 feet above S. H. W.; new curtain, to the same grade, was attached to Dike E. Commenced October 10, completed October 14.

The average cost of abatis was $1.50 per linear foot; of hurdle, $0.65 per linear foot. (See Appendix, Exhibit B.)

Dike construction.—It was deemed essential that at least one of the structures of the system for the proposed rectification should be of more substantial form than abatis, which is regarded as a temporary expedient, to be used as an auxiliary rather than a principal work, and in positions not fully exposed. The third member of the system was therefore made a pile dike (Dike F), and built under standard dike specifications with 10-foot spacing, as follows: From the shore out, 204 feet, of one-row work; then for 102 feet, two rows, and the outer 495 feet, three-row work; in all, 801 linear feet of dike. The grade of the dike slopes from 1 foot above S. H. W. at the shore to S. H. W. 306 feet out, and thence to the stream end slopes to 4.5 feet above S. L. W. The work was accomplished between August 24 and October 1. It cost $5,385.79, or an average of $6.724 per linear foot. The details of cost and quantities of materials expended are given in the Appendix, Exhibit C.

Revetment construction.—The construction of the revetment provided for in the project for the fixation of the head of the towhead was commenced September 9 and completed October 21. Six hundred and fifty-one linear feet of practically standard revetment were constructed.

The mattress, 59,454 square feet in area, was woven in place in one piece on the dry shore bar, after clearing away the driftwood and smoothing down some irregularities in surface. The general level of the bar covered by the mattress was approximately 6½ feet above S. L. W.

The grading for upper bank protection was done with plow and scrapers after the mattress had been made. The total cost of the revetment was $3,681.51, or $5.65 per linear foot. Elements of work and cost are shown in item in the Appendix, Exhibit D.

Procuring construction materials.—The brush and poles used on this work—744 cords of the former and 262.5 cords of the latter—were procured in the immediate vicinity by hired labor, at an average cost, delivered on the work, of $1.65 per cord of brush and $3.38 per cord of poles. Of the stone used, 1,386.84 cubic yards were furnished under informal contract at $1.28 per cubic yard, delivered on barges at Jefferson City, and 198.55 cubic yards from storage pile, previously acquired at mouth of Moreau River. The cottonwood lumber, aggregating 43,098 feet B. M., used in abatis construction was furnished under informal contract at $13 per 1,000 feet B. M. on barges, 47 miles below the work. The long-leaved pine piling and bracing lumber, used in dike construction, was taken from stock on hand at Gasconade yard. The three-eighths inch galvanized strand and nails were furnished under informal contract. The bolts and strand clips were furnished in part from stock and by hired labor, at the Gasconade boatyard.

Towboat and other plant service.—The towboat service was performed by the U. S. tender *Sabrina*. She was actively engaged on the work sixty-six days. The only other hulls used were as follows: A 64-foot barge used in constructing and launching abatis, over water, a pile driver and mattress boat, used in construction of Dike F, and two cross boats and three 100-foot barges, as carriers of materials.

Effects of work and present conditions.—The accompanying maps and cross sections of river (Pl. I) show that the left-shore bar has been materially raised by deposit and advanced well out to the approved line of rectification. The chute has not been entirely closed, though it has been reduced to such an extent that the flow through it, even at flood stages, would have little effect upon the local regimen of the river.

Abatis No. 4 has been damaged to some extent by drift and the loss, due to scour, of some of its anchorage. A section of it near the towhead, about 225 feet in length, is breached in several places and requires renewal.

The other works are intact, but it is hardly to be expected that abatis No. 1 will much longer withstand the strong and persistent attack to which it is subjected. The situation calls for a pile dike there, of standard three-row work, or, what would be better still, the masking of the bay in the right shore above the bridge. The latter would not only afford relief to the works opposite Jefferson City, but do much toward the accomplishment of the desired shifting of the channel toward the Jefferson City side, and, incidentally, secure a much needed improvement in the conditions of the flow, affecting navigation through the draw spans of the Jefferson City bridge.

NEW JUNCTION OF OSAGE AND MISSOURI RIVERS.

Since the cessation of the work in the cut through Osage Point, February 25, 1899, the relative stages of the two rivers, when in flood, have been such that there was

little flow through the cut. In fact, the bottom of the cut has been raised by deposit to a general level, about 9.5 feet above S. L. W., and is overgrown with weeds.

CHAMOIS REACH.

Revetment repairs.—A section, 760 feet in length, of upper bank work of the Chamois revetment having become partially denuded of its stone paving, authority was verbally given on the 2d of November to reenforce and regrade it where necessary. The section of work referred to lies between 8,590 and 9,350 feet below the head of the Chamois revetment. At the time the revetment was built, in June, 1895, a shore bar that was dry at S. L. W., and of greater width than the mattress, extended along its front, so that the mattress in its first position was entirely above S. L. W. Subsequently the bar was scoured out and, at the time these repairs were made, the outer selvage of mattress rested on the bottom at 20 to 36 feet below S. L. W. In following the scour the mattress was severely strained. In bending over the sharp knuckle at the surface, formed by the slowly receding foreshore, the meshes of the mattress were opened somewhat and much of the paving stone rolled down on the subaqueous mattress. Deteriorated by age and thus exposed, the upper mattress could not be relied upon.

Work was commenced November 8 and completed December 8. The length of upper bank repaved was 760 feet, of which 200 linear feet were regraded. The total expenditure of stone was 772 cubic yards. The cost of the work was $748.38, as shown in Appendix E. The stone used was procured by hired labor from a quarry in the right bluff at Chamois and wagoned to point of expenditure. Before suspending operations 1,089 cubic yards of stone were taken from the same quarry and stored on the revetment just below the repaired work for emergency use. The cost of this stone, in storage piles, was 86 cents per cubic yard.

Chamois bankhead (Pl. VI).—This structure, built in the spring of 1897, received no attention in the way of repairs or maintenance during the year. It appears to be in excellent condition. There has been practically no caving of the bank above it for a distance of 3,600 feet, to foot of the Chamois revetment, and no caving below the bankhead for a distance of 1,200 feet, although the stretches of bank referred to are otherwise unprotected, and for most of the time, the main volume of the flow has passed in front of the bankhead.

GASCONADE BOAT AND SUPPLY YARD.

A force commensurate with the varying requirements of the service was kept employed in the boat and supply yard throughout the year. To a large extent it was made the outfitting, repair, and supply point for all the works. The new barges authorized in the previous year were built on the yard ways; most of the important plant repairs were made there; all of the floating plant, tools, and supplies not out on detached works were cared for there; large quantities of dike bolts, cable clips, and other fastenings, special tools and devices, were manufactured for use on detached works.

New plant.—The construction of the twelve new 100-foot barges was heavily handicapped by the failure on the part of the contractors to make deliveries of the oak and fir lumber in quantity and assortment of sizes as required. It was confidently expected that some, if not the majority, of the barges would be completed in time for use on the fall work. But deliveries dragged so that all measures for economic work were defeated, and finally the funds were exhausted and it became necessary to suspend operations on February 22 with the work in an unfinished condition. The first consignment of fir lumber, four carloads, arrived at the yard on July 27; the last one reached there November 24. The intermediate shipments were made at irregular intervals and with utter disregard of the requirements of the work as to assortment of sizes. Because of these conditions it was the 13th of October before a full bill of lumber necessary for two barges was received. The deliveries of oak lumber were more unsatisfactory than those of the fir. The bill was still incomplete when work was suspended, and the order for the balance rescinded. Two barges were completed and launched—the first one on October 25, the second five days later. The other ten barges were in various stages of completion, two of them requiring only to be calked and two others but little additional work to bring them to completion. By your direction work was resumed with a small force on June 26 and is still in progress. The status of work on the ten barges at the close of the year, expressed in percentages, begin as follows: Barge C, 84 per cent, Barge D, 63 per cent, Barge E, 62 per cent, Barge F, 63 per cent, Barge G, 68 per cent, Barge H, 85 per cent, Barge I, 71 per cent, Barge K, 68 per cent, Barge L, 84 per cent, and Barge M, 85 per cent toward completion.

The total expenditure on account of the new barges was $30,390.30, of which $2,730.69 was expended during the previous fiscal year, as shown in the appendix,

Exhibit F. This amount was charged off as follows: To the allotment for new plant, $18,000; to the allotment for Pelican Bend, $12,102.96, and to First Reach, $2[illegible]. The estimated cost of completing the barges is $3,500, which would make the final average cost of each barge $2,824.19.

Repair of plant.—During the year the following pieces were repaired at the yard: The steam tenders *Melusina* and *Arethusa*, the naphtha launch *Enquirer*, three large quarter boats, hydraulic grading boat No. 7, three mattress boats, two 100-foot barges, and one 64-foot barge. All the repairs were comparatively light, only such work being done as was deemed necessary to meet the demands of the season's service.

In July, from the 9th to the 14th, all of the plant and construction materials stored at Osage Point and in the old supply yard at Bonnots Mill were removed and stored in the yard at Gasconade. The total cost of the work, including the services of the tender *Arethusa* for seven days, was $574.13.

On November 25 the condemned steamer *Golden Gate*, which had been sold September 25, was launched and turned over to her owner.

On May 30 the unserviceable property which had accumulated since the previous inspection in May, 1899, was inspected and condemned by Col. J. W. Barlow, Corps of Engineers.

SURVEYS.

During the year the following surveys were made in addition to the usual work of that kind involved in construction:

October 14 to 19, hydrographic survey of approaches to Chamois bankhead.

In November a shore-line survey and some partial cross sections of the river were made in the vicinity of the break in the revetment at the head of Murrays Bend.

In the same month a hydrographic survey of the river was made in the vicinity of Jefferson City, with a view of locating the new improvement works there and studying their effects on the conditions of flow. There was also a partial survey made in the same month of the right bank in the vicinity of Dike 33 C, to show the extent of bank caving there since the loss of Dike 33 B.

In May cross sections of the river at Jefferson City were again sounded to ascertain the effects of the new works of rectification.

On June 14 a shore-line survey of the right bank was made from the foot of Chamois revetment to the Chamois bankhead, in order to determine to what extent, if any, the bank had receded.

SPECIAL EXAMINATIONS AND REPORTS.

In compliance with instructions contained in your letter, dated February 17, special examinations were made June 12 and 13 by Assistant Engineer R. A. Crawford of some dikes built by resident landowners in the localities of Bates Bend, Bernheimer, Mo., Marthasville Bend, and below Washington, Mo. His reports in the matter were forwarded to you June 25. It appears that in no case was permission for the construction of these dikes obtained from the Secretary of War, as provided for in section 9 of the river and harbor act, approved March 3, 1899. With the exception of those at Bernheimer, Mo., none of these structures is close to or materially affect the channel of the river. The object in view appears to have been the protection rather than the reclamation of land. The dikes at Bernheimer, three in number, are at the head of Jaegers Bend, in the direct line of flow of the river. They are so short, however, that the channel is not materially deflected by them, and, as the range of line of approach is limited by the bluff shore, it is thought that no bad results other than the subversion of the law will obtain.

DAMAGES TO WORKS.

The following is a complete list of works on Gasconade Division now in a damaged condition: Murrays Bend revetment, Dike D, *abatis No. 4* (above mentioned), Dike P, 1, 2, *3*, 17, *18*, 19 A, 19 B, 23, sheer dike above 29 A, Dikes *29 C*, 32, 33 B entirely destroyed, *33 C*, 35, XX A, XXII A, *XI A*, *XI B*, *XXVIII A*, hurdle at shore end of upper abatis above Hardins Island, Dikes *II*, *VIII*, *XV*, *XXIII*, XXXII, and XXXIV, those in italics having been added during the current year.

Of the others, the following dikes appear to be in much the same condition as when first damaged, except that each has been shortened or the breach in it widened somewhat: Dikes P. 1, 2, 17, 19 A, 19 B, 23, sheer dike above 29 A, Dikes 32, 35, XX A, XXII A, hurdle at shore end of upper abatis above Hardins Island, Dikes XXII and XXXIV.

Murray's Bend revetment.—The break in this work, referred to in my last annual report, has continued to increase. When last examined, June 11, about 425 lineal feet of the revetment, from the old mouth of Cedar Creek down, had been completely destroyed. The main flow of the river impinges against the bank there with great force, and it has receded to such an extent that a prominent shoulder has formed at

the head of the work, making further destruction of the revetment certain and rapid. The upper bank work of this revetment was originally considerably lighter than the present practice, and since it was built, in 1892, has been denuded more or less all along. In places, aggregating about 600 linear feet, slight settlements have occurred. The bank is composed of very light sand, and failure on an extensive scale will surely follow unless the upper bank be reenforced. A covering of spawls, about 1 cubic yard per linear foot, placed between contours 10 feet above and 3 feet below S. L. W., is recommended.

Dike D (opposite Jefferson City, Mo.).—The upper wales on four bents near the stream end of this dike have been broken by the weight of drift on top of the structure.

Dike 3 (left bank below mouth of Moreau River).—The outer end of this dike was uncovered by erosion due to the flow through the break in Dike No. 1, and the shortening of the intermediate Dike No. 2. The structure was in such an advanced stage of decay that it offered little resistance to the destructive forces of the river. About four bents at the stream end of the dike have been destroyed. It is not known when the damage occurred.

Dike 18.—When examined on June 11 the lower pile and bracing of the stream end bent of the dike were missing.

Dike 29 C.—The stream end bent of this structure is missing.

Dike 33C.—The loss of Dike 33 B exposed Dike 33 C to a violent attack. The old accretions above it rapidly receded in the form of a short bend, the dike at the lower end of the bend being uncovered as the line of accretions receded. The outside reef closely followed, producing conditions under which the extent of scour, within ordinary limits, was only dependent upon the resistance offered by the dike. When examined June 11 the outer 420 feet of the structure had been destroyed, leaving but 280 feet of dike standing.

Dikes XI A and XI B (Chamois Reach).—The outer ends of both of these structures have been damaged somewhat; the head clusters and two outer bents are missing in XI A, and the head clusters and stream-end bent in XI B. The curtain in the outer ten bents of the latter structure is also missing.

Dike XXVIII A' (Chamois Reach).—The trail and twenty-seven bents of the outer end of this dike were scoured out and carried away some time in July.

Dike II (opposite Little Tavern Creek).—This structure was breached in two places during July by scour due to longitudinal flow along its upper row. The inshore breach is about 100 feet in length, beginning at a point 375 feet inshore from stream end of the dike. The dike was breached here from the same cause in December, 1895, and repaired in the following spring. The outer breach is about 100 feet long, just inshore from the trail. The latter is standing. Some of the top diagonal braces on the dike between the two breaches are missing. It is very much exposed and until protected by some works above can hardly be expected to withstand the attacks to which it is subjected.

Dikes VIII and XV.—The outer ends of these dikes are thought to have been recently damaged, but to what extent was not ascertained on account of the high stage of river. The breaches in the shore-bar extension work of Dike VIII, recently reported, appear not to have changed.

Dike XXIII (south bank of Heckmanns Island).—Again this structure has been breached, this time, so far as is known, due to the severity of the attack of the river. In low stages the flow is directed against the dike by the shoulder in the main right bank below Baily Creek. In flood stages the flow in the chute to the south of Millers Island tends to produce the same effect. The breach is about 110 feet long, extending inshore from a point 434 feet from the stream end of the dike. It is in the new work with which a breach in the dike was repaired last year.

Very respectfully, your obedient servant,

S. WATERS FOX, *Division Engineer.*

Lieut. Col. AMOS STICKNEY,
Corps of Engineers, U. S. A.,
President Missouri River Commission.

LIST OF EXHIBITS FORMING THE APPENDIX TO FOREGOING REPORT.

A. Classified statement of money expenditures during the year.
B. Elements of work and cost in detail of abatis construction, Jefferson City Reach.
C. Elements of work and cost in detail of Dike F, Jefferson City Reach.
D. Elements of work and cost in detail of 651 linear feet of revetment, Jefferson City Reach.
E. Elements of work and cost in detail of repairs to revetment, Chamois Reach.
F. Expenditures on account of plant during fiscal year.

EXHIBIT A.

Classified statement of money expenditures under allotments for work on Gasconade Riv[er] during the fiscal year ending June 30, 1900.

Classification.	First reach, act of 1898.	First reach, act of 1899.	New plant, river and harbor act of 1899.	New plant, sundry civil act of 1899.	At Jefferson City, Mo.	Tota
Actual expenditure on account of construction work for labor and materials	$2,668.11	$52.85	$1,698.96	$12,515.07	$11,545.71	$28,4[illegible]
Towboat service while directly engaged in construction	99.67				1,465.05	1,56[illegible]
Total	2,767.78	52.85	1,698.96	12,515.07	13,010.76	a30,04[illegible]
All other plant service, including repairs, watching, and moving from place to place	2,658.79	1,578.89			1,062.60	b5,30[illegible]
Administration charges, Jefferson City office and field	1,316.70	825.31	75.35	932.76	1,501.67	c4,65[illegible]
All other charges:						
New plant	12.75			14.25	121.55	[illegible]
Surveys	388.76	3.60			126.04	[illegible]
Total	401.51	3.60		14.25	247.59	d6[illegible]
Grand total	7,144.78	2,460.65	1,769.31	13,462.08	15,822.62	40,65[illegible]

a About 74 per cent of grand total expenditures.
b About 13 per cent of grand total expenditu[illegible]
c About 11 per cent of grand total expenditures.
d About 2 per cent of grand total expenditu[illegible]

EXHIBIT B.

Elements of work and cost in detail of abatis 1, 2, 3, 4, and E, 3,080.6 linear feet, [illegible] hurdle, E, 234.3 linear feet, Jefferson City Reach, constructed during September, Oct[illegible] and November, 1899.

Classification.	Cost in item.	Tota
Abatis construction:		
43,098 feet B. M. cottonwood lumber	$776.07	
83 cords brush	54.41	
221 cords poles	747.54	
305 cubic yards stone	534.36	
5,370 pounds ½-inch strand	463.07	
4,528 pounds nails and spikes a	114.80	
3,066 pounds screw bolts	156.89	
1,024 linear feet pine piling b	165.89	
45 linear feet cottonwood piling b	3.60	
150 bushels coal	16.16	
Labor as follows:		
Framing	487.42	
Curtaining	671.09	
Ballasting	70.33	
Anchoring	192.97	
All other items incidental to construction	168.16	
Total cost of abatis construction, at $1.50 per linear foot		$4,622.[illegible]
Hurdle construction:		
16 cords brush	26.40	
4 cords poles	13.52	
26 pounds nails	.83	
Labor	113.23	
Total cost of hurdle construction, at $0.6566 per linear foot		153.[illegible]
Grand total cost of abatis and hurdle work		4,776.[illegible]

a From stock on hand, paid for by first reach.
b 2,914 pounds spikes from stock on hand, paid for by first reach.

EXHIBIT C.

Elements of work and cost in detail of Dike F, Jefferson City Reach, constructed during August, September, and October, 1899.

Classification.	Quantity.	Cost.
21 piling as follows:		
Cypress, 6 *a* ..... linear feet..	240	$19.20
Cottonwood, 2 *a* ..... do....	98	11.30
Pine, 213 *a* ..... do....	7,232	1,171.58
Wales and braces, long-leaf yellow pine *b* ..... feet B. M..	19,217	195.85
Stone delivered on work ..... cubic yards..	305	543.36
Brush and poles delivered on work ..... cords..	335.5	618.10
Three-eighths-inch strand, mooring and lashing foot mattress ..... pounds..	1,560	87.52
Three-fourths-inch strand, bracing ..... do....	4,000	100.00
Bolts, washers, spikes, etc ..... do....	3,291	146.17
Cable clips	374	18.95
Labor as follows:		
Pile driving	.....	399.77
Weaving and sinking	.....	514.55
Bracing	.....	415.25
Curtaining	.....	48.20
Coal, oils, waste, etc	.....	46.77
Steamboat service:		
Towing all supplies, etc., construction materials, except stone and brush, moving construction parties and their plant	.....	418.20
All other items incidental to construction	.....	636.02
Total cost	.....	5,385.79

a From stock on hand, paid for by First Reach.
b 7,818 feet B. M. of these amounts was recovered lumber, for which there was no first cost included in this exhibit. The remainder is from stock on hand paid for by First Reach.

EXHIBIT D.

Elements of work and cost in detail of 651 linear feet of revetment, Jefferson City Reach, constructed during September and October, 1899.

Classification.	Cost in item.	Total.
Grading bank, 609 linear feet, containing 2,319 cubic yards of earth:		
Labor, at $0.1242 per cubic yard	.....	$288.03
Construction and anchorage of mattress, 651 linear feet, or 59,454 square feet:		
Brush, 397 cords	$654.58	
Three-eighths-inch strand, 4,724 pounds	265.02	
Pine piling, 144 linear feet (dead men)	16.20	
Cable clips, 222 pounds	17.43	
Labor and subsistence	468.25	
Total cost, at $2.184 per linear foot	.....	1,421.43
Ballasting mattress and bank, 975 cubic yards:		
Stone, 975.39 cubic yards *a*	1,708.88	
Labor	263.17	
Total cost, at $2.022 per cubic yard	.....	1,972.05
Grand total cost of 651 linear feet of revetment, at $5.655 per linear foot.	.....	3,681.51

a 198.55 cubic yards were from supply on hand, paid for by First Reach.

EXHIBIT E.

Elements of work and cost in detail of repairs to revetment in Chamois Bend during November and December, 1899.

Classification.	Cost in item.	Total.
Regrading bank, 200 linear feet:		
Labor	.....	$36.00
Repairs to revetment, 760 linear feet:		
Stone, 772 cubic yards	$669.94	
Cable clips, 22.5 pounds	1.13	
Labor	133.98	
Total cost of repairs	.....	705.05
All other charges	.....	7.33
Grand total cost of repairs	.....	748.38

EXHIBIT F.

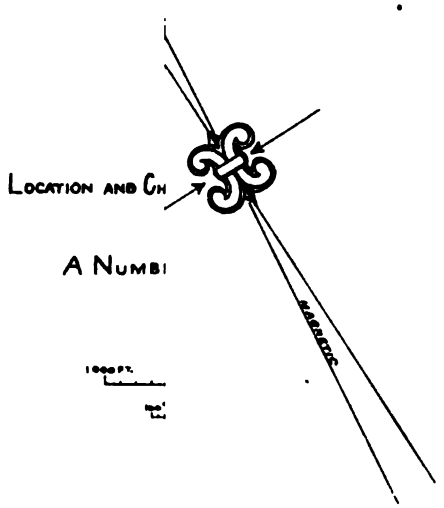
Expenditure on account of plant during fiscal year ending June 30, 1900.

	Labor.	Subsistence.	Supplies.	Materials.	[illegible]
Care of plant, watching:					
Gasconade division	$3,184.59	$745.95	$54.56	$35.76	$[illegible]
Local works below Kansas City	6,075.81	1,417.61	372.18	.....	[illegible]
Omaha division	2,208.26	305.17	118.48	.....	[illegible]
Pulling out (1 hull), Gasconade division	19.81	7.38	1.17	.....	[illegible]
Launching (6 hulls), local works below Kansas City	116.54	49.17	16.13	.....	[illegible]
Cleaning, sorting, and storing:					
Gasconade division	201.61	78.78	.43	4.41	[illegible]
Local works below Kansas City	110.37	41.89	5.73	.....	[illegible]
Omaha division	55.95	17.20	.....	.....	[illegible]
Total	11,972.46	2,658.10	568.68	40.17	[illegible]
Repairs and alterations:					
Yard plant—					
Gasconade division	425.88	106.22	.....	198.61	[illegible]
Floating plant—					
Gasconade division	144.68	33.36	16.06	20.05	[illegible]
Local works below Kansas City	1,684.62	352.45	252.51	848.12	[illegible]
Omaha division	1,070.59	90.95	.....	529.56	[illegible]
Current, miscellaneous:					
Gasconade division	123.09	28.32	.....	32.08	[illegible]
Local works below Kansas City	379.73	42.46	12.22	176.41	[illegible]
Total	3,828.59	653.76	280.79	1,804.83	[illegible]
New plant constructed:					
12 barges, 25 by 100 feet, the cost of construction during the fiscal year being as follows:					
Fir lumber	.....	.....	.....	6,273.00	[illegible]
Freight charges on fir lumber a	.....	.....	.....	.....	[illegible]
Inspection of fir lumber	436.00	.....	.....	.....	[illegible]
Oak lumber	.....	.....	.....	1,161.48	[illegible]
Unloading and handling lumber	329.73	158.89	.....	.....	[illegible]
Iron, spikes, and other materials	.....	.....	.....	1,683.76	[illegible]
Making bolts and other iron fittings	277.56	71.76	.....	.....	[illegible]
Milling lumber, framing, and setting up	7,611.23	1,901.33	436.92	.....	[illegible]
Administration	1,037.00	166.95	.....	.....	[illegible]
Traveling expenses, telegrams, etc	.....	.....	.....	.....	[illegible]
All other incidental charges	244.85	90.72	.....	.....	[illegible]
Total expenditure during fiscal year on account of new barges	9,936.37	2,389.65	436.92	9,118.24	[illegible]
Five cases, drawing	55.90	13.10	.....	16.31	[illegible]
Two spanners	1.13	.25	.05	.24	[illegible]
Total	9,993.40	2,408.00	436.97	9,134.79	[illegible]
New plant purchased:					
Gasconade division—					
Rope, manila	.....	.....	.....	.....	[illegible]
Hose, steam	.....	.....	.....	.....	[illegible]
Tapes and saws	.....	.....	.....	.....	[illegible]
Local works below Kansas City—					
Rope, manila	.....	.....	.....	.....	[illegible]
Hose, steam and water	.....	.....	.....	.....	[illegible]
Wheelbarrows, shovels, files, augers, etc	.....	.....	.....	.....	[illegible]
Brooms, mops, dishes, etc	.....	.....	.....	.....	[illegible]
Omaha division—					
Rope, manila	.....	.....	.....	.....	[illegible]
Hose, steam	.....	.....	.....	.....	[illegible]
Wheelbarrows, shovels, axes, etc	.....	.....	.....	.....	[illegible]
Brooms, mops, brushes, etc	.....	.....	.....	.....	[illegible]
Total	.....	.....	.....	.....	[illegible]
Miscellaneous:					
Preparation of property for condemnation and disposition of same	226.44	147.52	8.69	16.49	[illegible]
Shifting plant on ways	92.14	44.17	6.40	.....	[illegible]
Steamboat service, moving plant—					
Gasconade division	.....	.....	.....	.....	[illegible]
Local works below Kansas City	.....	.....	.....	.....	[illegible]
Omaha division	.....	.....	.....	.....	[illegible]
Total	318.58	191.69	10.09	16.49	[illegible]
Grand total	26,118.03	5,906.55	1,296.53	10,996.28	[illegible]

a This amount is estimated. The shipments were made by the quartermaster department, and settlement of freight accounts had not been made at close of fiscal year.

b During the previous fiscal year $2,730.69 had been expended on account of new barges, making total during both fiscal years of $30,390.50.

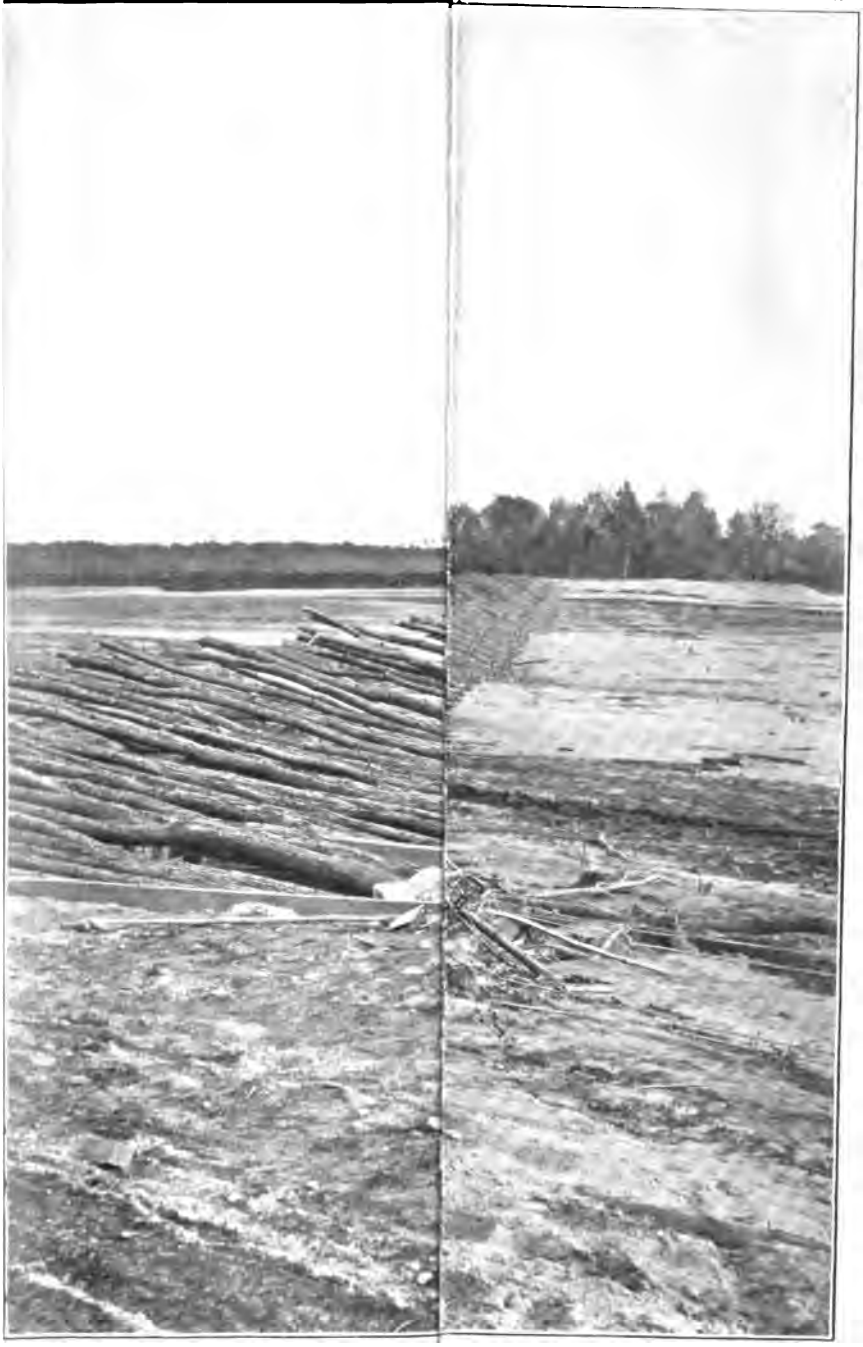
MISS



Asst. Eng'r.

Eng 56 2

PLATE II.



JEFFERSON CITY REACH. ABATTIS NO. 4. ON HEAD OF TOWHEAD IS SEEN IN

APPENDIX E.

ANNUAL REPORT ON LOCAL WORKS BELOW KANSAS CITY, MO., BY MR. S. WATERS FOX, DIVISION ENGINEER.

MISSOURI RIVER COMMISSION,
Jefferson City, Mo., June 30, 1900.

COLONEL: I have the honor to submit the following annual report for the fiscal year ending June 30, 1900, of operations on local works below Kansas City, Mo.:

Work was done at Randolph, above the mouth of the Little Blue River, at Lexington, at Miami, above Glasgow, in Nigger Bend, above Rocheport, near Huntsdale, and in Pelican Bend. It comprised the construction of revetment at five of the points named, aggregating 11,971 linear feet; revetment maintenance above Glasgow; the construction of dikes at Lexington, and dike repairs above the mouth of Little Blue River and at Miami, aggregating 1,477.1 linear feet of new three-row work; the extension, repair, and maintenance of three bankheads above Glasgow and one above Rocheport; surveying; care and repair of plant, and miscellaneous incidental work.

The total expenditure during the year was $145,216.83, as shown in the appendix, Exhibit A.

The following illustrations accompany:

Ten maps (Pls. I to IV A and V to IX) of Missouri River, showing the location and character of the improvement works constructed during the year on each of the reaches excepting at Miami, where no survey was made.

Four plans (Pls. X to XIII) of bank heads 4 C, 5 C, 6 C, and 1 D, showing pile work with which each of these structures was extended.

Four photographic views (Pls. XIV to XVII), showing pile extension work at Bankhead 4 C in process of construction and completed.

Seven photographic views (Pls. XVIII to XXIV) of revetments constructed during the year.

One photographic view (Pl. XXV), winter harbor below Musics Ferry.

AT RANDOLPH.

[See accompanying map (Pl. I).]

Project.—It was proposed to expend the sum of $12,000, allotted from the appropriation for improving the Missouri River from its mouth to Sioux City, Iowa, in sundry civil act of March 3, 1899, in building about 1,200 linear feet of revetment in front of the town of Randolph.

Revetment construction.—Notification of the approval of project was received under the date of January 6, 1900, but, owing principally to restrictions imposed by the limited floating plant available, revetment construction was not commenced until May 1.

In the interim most of the working plant construction materials and supplies were assembled on the work.

Between the 1st and the 28th of May, 1,200 linear feet of revetment were built as nearly in accordance with standard specifications as the existing stage of river permitted. While the work was in progress the stage of river varied from 6 to 10 feet above S. L. W., alternately rising and falling, but with a general upward tendency. The inner selvage of the mattress was laid about 1 foot higher than the water surface at the time it was woven. It was completed on the 21st of May, when the stage was about 8 feet, so that its inner edge lies in an irregular line between contours 7 feet and 9 feet above S. L. W. The upper bank was paved from a contour 2 feet above S. H. W down to about 2 feet below water surface. The remainder of the upper bank work down to the minus 3-foot contour (submerged at the time) was given about five-eighths of the specified quantity of stone, distributed as nearly as possible in place. The subaqueous mattress beyond the minus 3-foot contour received the full quantity of stone and 50 cubic yards extra on 50 linear feet at the head. As a reenforcement against flanking, 55.62 cubic yards of stone were expended on the upper bank at the head of the revetment. For a length of 90 feet, near the head of the work, the bank was below S. H. W. It was raised to the general level of the adjacent bank (1.84 feet above S. H. W.) by a levee of that length, built so that its river slope, when paved, conformed to and was part of the upper bank work of the revetment.

The mattress was woven in one piece 1,207 feet long. It extends 7 feet farther downstream than the upper bank work.

The cost of the work was $8,046.28, or $6.70 per linear foot. The elements of work and cost in detail are given in the appendix, Exhibit B.

The accompanying photograph (Pl. XIX) shows the work after completion.

LITTLE BLUE REACH.

[See accompanying map (Pl. II).]

Project.—Two allotments were made for work on this reach, viz, from the river and harbor act of March 3, 1899, the sum of $5,000, and from the sundry civil act of March 3, 1899, $10,000.

The project for the expenditure of the former amount, approved July 29, 1899, contemplated the construction of a revetment around the head of Blue Mills Island 500 or 600 feet in length, the balance to be held in reserve for such work as might be necessary at Bankhead 3 A, or other points on the reach, The project for the expenditure of the $10,000, approved July 29, 1899, provided for the restoration of Dike 2 A, by 600 linear feet of new three-row work just above it, and for the construction of 500 feet of revetment on the shoulder of the island below to prevent further recession.

Dike 2 A, restoration and repair.—As originally built this dike, completed September 17, 1898, was 1,140 feet long; connected at the shore end with the old main dike by 225 feet of mattress laid on the surface of an intervening bench of low ground. It was considered a very substantial structure, being fully up to the best practice. The breaching of the dike on April 20, 1899, just when the attainment of the object for which it was built seemed assured, also the measures taken later on for its restoration, but abandoned on account of high water, were mentioned in my last annual report.

Work was resumed August 10, after a suspension of two months, and completed September 15. During that time practically all of the restoration work previously done was destroyed, and the left bank continued to recede by erosion until the length of dike necessary to fill the opening was 830 feet. Of this, 460 feet was the measure of the bank recession and 370 feet of the loss of the 37 bents of the old dike. Depths and velocities in the opening had decreased to such an extent that it was found practicable to build the new work on the line of old. Between August 10 and September 15 the opening was closed with 830 linear feet of three-row work, making the total length of the dike 1,609 feet. Cottonwood piling and lumber were used. In all other respects standard specifications for three-row work with 10 feet spacing were followed. Some very hard driving was encountered, and in order to avoid shattering the piles with the heavy Cram hammer, a hydraulic jet, furnished from a gradient boat alongside the driver, was used as an auxiliary. A dry bar at the outer end of the new work made it necessary to unship one of the drivers and use it as a leader. An average penetration of 24.08 feet was attained in the new work.

The cost of the work was $6,780.73, as shown in item in the appendix, Exhibit.

After restoration the dike stood without injury until the ice movement in March. An examination on the 4th of April disclosed that the upper piles in the sixth and tenth bents from shore end of the dike had been broken off at the water surface and that the dike had been practically stripped of its curtain from the fourth to the forty-fifth bent. A dry bar, about as high as the dike, extending some distance above and below, had formed from the stream end of the dike inshore for five bents, and a waterway through the dike 700 feet wide, carrying a large percentage of the total flow, extended from the bar to the main left bank, which was caving both above and below the dike. Between the 17th and 20th of April the dike was reenforced by additional bracing on and near the injured bents. The curtain was restored only from the shore to Bent 10, the object being to induce the flow to leave the shore. This was accomplished to a marked degree, but it became more and more apparent that, without the aid of at least one other structure, Dike 2 A would fail to accomplish the closing of the chute. In June there was a settlement of the mattress at the root of the dike that released many of the curtain poles. A current developed there and threatened to flank the dike. Between the 4th and 8th a new curtain was attached to each row of the dike, from the bank 64 feet, again deadening the flow next to the shore. The total cost of repairs in April and June was $195.47. An examination of the dike on June 19 disclosed a gap in the structure 90 feet long, extending from the fourth to the thirteenth bent. It was learned that the breach occurred during a rise on June 10.

Revetment construction at head of Blue Mills Island.—When this work was commenced August 25, it was found that the extensive accretions which had formed at the head of the island and in the old channel to the south of it were so embedded with heavy driftwood that it was necessary to protect only the north shore. Later on, while the work was in progress, the conditions of flow indicated that an attack on the upper portion of the north shore of the island was not probable and you authorized a further curtailment of the proposed revetment at its lower end. Starting as far up on the accretions at the head of the island as the drift permitted, 460 linear

feet of revetment were built between August 25 and September 16. The driftwood at the head of the island, as far as practicable, was made fast with three-eighths inch strand.

Standard specifications were followed except that in 170 linear feet of upper bank work at the lower end of the revetment spalls alone were used above the 6.5-foot contour, the supply of paving stone having been exhausted. Such practice has often been resorted to on works under my charge and with uniformly good results. The cost of the revetment was $3,140.83, or $6.828 per linear foot. The elements of work and cost are shown in the appendix, Exhibit D. The accompanying photograph (Pl. XVIII) shows the work seven months after completion.

Conditions of the flow.—Since the closing of the channel to the south of Blue Mills Island by Dike 1 A, in the fall of 1897, the bank below the island has been subjected to a stronger attack than previously, and has receded more or less all along from the foot of the island to the head of the bay, above Bankhead 3 A. Here the main channel leaves the right bank and passes to the left of a large middle bar that has formed in the bay.

LEXINGTON REACH.

[See accompanying map (Pl. III).]

Project.—The project, approved July 29, for the expenditure of the sum of $8,000, allotted for work at Lexington, Mo., from the sundry civil act of March 3, 1899, provided for the construction of four pile dikes, aggregating 857 feet in length, from the left bank in the bend above the town. From a later survey it was found that the total lengths of dikes required to reach the approved line of rectification was 42 feet less than the above. It was hoped, by means of the dikes, to cause and maintain a higher crossing to the bluffs on the Lexington side and incidentally protect the river terminus of the Atchison, Topeka and Santa Fe Railway.

Dike construction, Dikes Nos. 1, 2, 3, and 4.—A survey of the approved locations of these dikes was made early in September, but construction work was not commenced until November 2. In the interim, plant, material, and supplies were assembled. The work was actively carried on until the 5th of December, when the funds were so nearly exhausted that it was necessary to suspend operations with the dikes in an unfinished condition. The status of the work on each of the dikes at that time was as follows:

Dike No. 1.—Projected length, 150 feet; measured length of dike as built, 150 feet; completed, except attaching 110 linear feet of curtain from Bent 4 to the end of the dike.

Dike No. 2.—Projected length, 240 feet; measured length of dike as built, 237 feet; completed, except attaching 182 linear feet of curtain from Bent 4 to the end of the dike.

Dike No. 3.—Projected length, 275 feet; measured length of dike as built, 105.4 feet; this portion completed, except attaching 53 linear feet of curtain from Bent 6 to end of dike. A bar prevented construction of this dike to its projected length.

Dike No. 4.—Projected length, 150 feet; measured length of dike as built, 154.7 feet; completed, except attaching 124.7 linear feet of curtain from Bent 3 to the end of the dike.

Between the dates of the 9th and 12th of April curtain was attached to these dikes, in addition to the above, as follows:

Dike No. 1.—Seventy-eight linear feet, between Bents 4 and 12.

Dike No. 2.—One hundred and fifty-two linear feet, between Bents 4 and 19

Dike No. 3.—Fifty-three linear feet between Bents 6 and 11.

The outer three bents of Dikes 1 and 2 (submerged at the time) were not curtained, and the curtain work on Dike No. 4 was not completed, the structure having been breached, as mentioned below.

Cottonwood piling and lumber were used. In all other respects standard specifications for three-row work with 10-foot spacing were followed. The grades of all dikes sloped from S. H. W., at the bank, to 10 feet above S. L. W., 100 feet inshore from their stream ends, and from there to 3 feet above S. L. W., at their stream ends.

After the general ice break-up, in March, it was found that Dike No. 4 had been breached from Bent 4 to 13, probably caused by a heavy run of ice. An examination on June 19 disclosed a widening of the breach by the loss of Bent No. 4.

The elements of work and cost in detail are shown in the appendix, Exhibit E.

MIAMI REACH.

An examination, September 6, of Dike 1 B disclosed a gap in that structure from Bent 125 to 130 and that the upper piles of the stream-end bent were broken. Neces-

sary repairs were authorized in September. The work was done between October 3 and 28, except that the curtain was not attached until later. Seventy linear feet new three-row pile work, 10-foot spacing, was built above the breach, overlapping the old work 10 feet at each end, and the upper piles of the stream-end bent were redriven and braced. Cottonwood piling and lumber were used. The cost of the work was $537.11.

GLASGOW REACH.

[See accompanying maps (Pls. IV and IV A).]

Project.—The work this year was done under two projects.

The project approved by the Chief of Engineers April 21, 1899, provided an item of $4,300 for groins and berms for bankheads 5 C and 6 C, of which $3,551.94 was available. The other project, approved August 10, 1899, was for the expenditure of $8,000 allotted from the sundry civil act of March 3, 1899, and provided for the extension of the bankheads to a connection with the bank on a curve of larger radius. The latter two sums mentioned and $24,304.32, from the allotment for repairs and contingencies, were expended in accordance with approved plans.

Bankhead 5 C, pile-work extension.—This work, which was commenced June 5, 1899, and in progress at the close of that fiscal year, was carried to completion November 25, after several temporary suspensions on account of the demands of work on other bankheads, stage of river, and other exigencies.

The plan of the work, as built (see accompanying plate, Pl. XI), was an amplification of that given in my last annual report. The two-row pile work on the 1,000-foot curve was extended down to radial 77 and the system of inside radial curtains, from the outer wall to the high bank, was extended to radial 73. One of the latter, on radial 41, was made of two-row work with foot mattress. On radials 76 and 77 three bents of two-row work, with foot mattress, connected the lower end of the outer wall with the old bankhead. All was built to bankhead grades. The outer wall foot mattress was in three pieces, as follows: The first piece, extending from the main bank at the upper end of the outer two-row work 100 feet to Bent 15, was 60 feet wide, its outer edge lying 40 feet beyond the 1,000-foot curve; this mattress was sunk to bottom throughout. The other two pieces of foot mattress were 120 feet wide, 20 feet lying inside and 100 feet outside of the 1,000-foot curve; the upper one was 425 feet long, extending from the bank at the head of the pile work to radial 46; the lower mattress was 406 feet long, overlapping the upper one 10 feet at the inner selvedge and 25 feet at the outer selvedge on radial 45, and extended 50 feet below the lower end of the outer wall; both of these mattresses were suspended at the piles in the outer two-row work at an elevation of 1 foot below S. L. W.; the outer edges were sunk to bottom and heavily ballasted, and enough stone was distributed over them elsewhere to overcome, with a safe margin, their buoyancy.

The cost of this work was $8,325.97, as shown in the appendix, Exhibit F.

Bankhead 5 C, construction of lower radial dike.—A large eddy, immediately below bankhead 5 C, became so strong and persistent that a two-row pile dike radial to the 1,000-foot curve through old post 61 was built with a view of stopping it. The dike was to serve also in checking direct flow whenever exposed to it.

Work on the structure was commenced August 2, but was suspended August 7 after twelve bents had been completed, on account of excessive depths and current. Work was resumed September 25 and carried to completion October 7. As completed, the structure was composed of twenty bents of two-row pile work, spaced 10 feet, and built to bankhead grades, its stream end lying at the 1,000-foot curve. It is shown in plan and cross section on the accompanying plate (Pl. XI).

The elements of work and cost are shown in the appendix, Exhibit F.

Bankhead 6 C, pile-work extension.—On the same general plan as at 5 C the shoulder in the bank above bankhead 6 C was masked with pile work. See accompanying plate (Pl. XII). Greater difficulties were encountered on this work on account of the great depths and velocities of flow.

The two-row work on the 1,000-foot curve extends from radial 61, 620 feet to the bank above. Two pieces of outer wall mattress were made. The first one, 60 feet wide, extended from the shore at the upper end of 1,000-foot curve 225 linear feet to 5 feet below radial 20, and was sunk to bottom throughout. The second mattress was woven in one piece from the bank at the upper end of 1,000-foot curve to 50 feet below lower end of outer wall; from the bank to radial 1 it was made 80 feet wide and from there down 120 feet wide; it was suspended throughout at the piles in outer wall at an elevation of 1 foot below S. L. W., the outer edge being sunk to bottom and enough stone thrown on it elsewhere to give free weight sufficient for stability.

The work was commenced August 5, and completed, after several interruptions, November 27. The cost and elements of work are shown in the appendix, Exhibit G.

Bankhead 6 C, construction of lower radial dikes.—For the same reasons that a lower radial dike was built below bankhead 5 C two such structures were placed below 6 C. The first of these, the lower one (see accompanying plate, Pl. XII), was constructed between October 18 and November 27. It lies on a radial to the 1,000-foot curve, 20–55 below the new directrix. As built, it was 174.5 feet long, of two-row pile work, spaced 10 feet and extending from main bank to the 1,000-foot curve and conformed to bankhead grades.

It developed that this dike was too far downstream, an objectionable and threatening eddy having formed above it, and after the partial destruction of the structure by ice in March it was decided to build another one between it and the bankhead. Work on the new dike was commenced April 5 and completed April 28. It is a two-row pile structure, spaced 10 feet in the rows, and the rows 14 feet. It is 143 feet long, built as near as possible to bankhead grades, and lies about midway between the old lower radial dike and radial 36 of the 350-foot curve; from shore, 72 feet, it was double braced and tied; both rows of piles were curtained. It is provided with a foot mattress 50 feet wide, from Bent 10, 28 feet beyond the stream end bent. From Bent No. 10, inshore to the bank, scour was provided against by 28 brush fascines, 4 feet by 15 feet, placed on the upper and lower side of the structure.

The cost and elements of work of the two dikes are shown in the appendix, Exhibit G.

Bankhead 4 C, remodification, pile work.—Plans for the remodification of this structure, with pile work, on practically the same lines as the new works at 5 C and 6 C, were prepared in accordance with your instructions of August 20 and subsequently approved by you. Briefly, the plans provided for a berm 75 feet wide, rising from 3.33 feet above S. L. W. at the outer wall to 6 feet at the foot of the upper cone; the upper cone to rise on a 1 on 2 slope to 20 feet above S. L. W.; the outer two-row work to lie in a curve of 1,000-foot radius, the center of which is 572.5 feet inshore from the center of the original structure, on a line produced, making an angle of 30° upstream from the old directrix (azimuth 246° 46′); the berm and upper cone were defined by radial curtain work extending from the outer wall to the high bank and spaced 40 feet apart on the 1,000-foot curve; these radial curtains were to be supported on single rows of piling, except the lower end one, which was made of two-row work from the outer wall to the top of the cone, and provided with a foot mattress 70 feet wide. A foot mattress 120 feet wide, extending from the bank at the upper end of the outer wall, 50 feet below the lower end of the wall, and suspended as those at the lower bankhead, was provided for. The work was commenced August 26 and completed in accordance with the plans October 20. Its cost and the elements of work are shown in the appendix, Exhibit H.

Bankhead 4 C, lower radial dike.—Anticipating the development of conditions at bankhead 4 C similar to those at 5 C and 6 C, a lower radial dike, about 300 feet below the bankhead, was authorized. It was built between the dates of August 26 and October 14. It was 169 feet long, composed of 2-row pile work; spaced 10 feet, built to bankhead grades and provided with foot mattress; both rows of piles were curtained. It lies on a line radial to the 1,000-foot curve, its stream end being on that curve. The cost and elements of work are shown in the appendix, Exhibit H.

Bankheads 4 C, 5 C, and 6 C, repairs and reenforcement.—On the subsidence of the June flood of 1899, it was found that the paved berm and upper cone of bankhead 6 C had been badly damaged during the flood. You directed that a series of nine stone dikes be built across the berm, between radials 3 and 27; the dikes to be 3 feet wide on top and conform to the grade of the modified berm; the upper cone to be rebuilt to grade with earth and paved. The work was accomplished as directed between October 9 and 28; 717.87 tons of stone were thus expended.

The three bankheads made a fine appearance after the completion of the pile work above described; the conditions of flow at and between the two lower structures were greatly improved, and there was promise of much greater improvement after their first exposure to flood. During a run of ice in the early part of January the bracing on pile work of outer walls and berms on the three bankheads was somewhat damaged. Between the 23d and 27th of that month a small party replaced 12 broken braces at bankhead 4 C, 16 at 5 C, and 7 at 6 C. In the general ice movement in the reach, March 8 and 10, all of the bankheads, including the lower radial dikes, were more or less injured. The two lower structures, particularly, and their lower radial dikes were subjected to a violent attack. The following damages resulted:

Bankhead 4 C.—In the 2-row work of 1,000-foot curve, 5 piles, 4 wales, and 2 braces were broken or missing; in one radial curtain the piles were bent over; the lower radial dike breached from Bent No. 4 to No. 10.

Bankhead 5 C.—In the 2-row work of 1,000-foot curve, 10 piles, 22 wales, and [illegible] braces broken and missing; practically all of the pile work in the upper cone a[illegible] inshore above radial 37 carried away; all high piles between radials 49 and [illegible] strained and out of line; lower radial dike breached from Bent No. 1 to No. 15.

Bankhead 6 C.—In the 2-row work of 1,000-foot curve, 10 piles, 22 wales, and [illegible] braces broken and missing; practically all of the pile work between the bank a[illegible] inner line of berm was destroyed; the stone berm and paved slope of 350-foot cir[illegible] work was more or less disturbed; the lower radial dike breached beyond Bent No.

Between the dates of March 28 and April 28 the following authorized reinforcement and repair work was accomplished:

Bankhead 4 C.—All high radial curtains secured against overturning by ties of wi[illegible] strand; breach in lower radial dike closed with 60 linear feet of abattis.

Bankhead 5 C.—Radial 24 restored by driving 2 new piles and replacing 50 lin[illegible] feet of curtain; 2-row work on radial No. 41 reinforced by an additional set of brac[illegible] attached at 9 feet above S. L. W.; the old berm reinforced by 10 heavy fascin[illegible] breach in lower radial dike closed with 8 bents of pile work and 55 linear feet abatis.

Bankhead 6 C.—A 2-row pile dike, conforming as near as possible to bankhe[illegible] grades, was built on radial 48, extending from shore 199 feet to the outer wall on [illegible] 1,000-foot curve. A double system of braces and ties were used over a part of [illegible] length and both rows of piles were curtained. The foot mattress was omitted, b[illegible] scour was provided for by heavy fascine work on the lower side of the dike; low[illegible] down 48 fascines were laid in two lines between radial No. 48 and radial No. 0 of t[illegible] old structure. To prevent further scour on the berm of the old structure, 31 fascin[illegible] were placed between 350-foot radials Nos. 8 and 9, 11 and 12, 14 and 15; 40 linear fe[illegible] of curtain on old lower radial dike replaced. For about 25 feet a portion of the riv[illegible] slope of the levee at bankhead 6 C had caved into the river. A reinforce levee [illegible] feet back of the old one, and 325 feet long, was built at an expenditure of $68.94.

The cost of repairs and reinforcement is shown in item in the appendix, Exhibit F, G, and H.

Cambridge revetment, repairs and maintenance.—This revetment was built by t[illegible] Chicago and Alton Railway Company, in the fall of 1889. It is considered a[illegible] important work from which to base a project for the improvement of the reach below During the months of October and November 749.77 tons of riprap stone and 201.5 tons of spawls were expended in reinforcing this revetment at its head and othe[illegible] points on the upper bank where indicated. The cost of the work was $1,390.80.

General conditions.—As the June flood of last year subsided the flow in Little Missouri Bend rapidly diminished, until the early fall, when it became insignifican[illegible] The flow following the main right bank below New Frankfort was practically tha[illegible] of the entire river. After leaving the main high right bank the flow divided int[illegible] four channels. The one making off to the right found its way past dike 3 C int[illegible] Wilhoites Bend, the point of confluence there ranging from about midway of bank[illegible] heads 4 C and 5 C to the latter structure. The flow in this channel rapidly diminished until, at low water, it represented but a small percentage of the volume A great bar formed in the bend above dike 3 C and the principal flow forced its wa[illegible] to the main left bank of the river in the other three channels above referred to. Th[illegible] middle one predominated, and during the entire year has been the main channel o[illegible] the river. Its impingement against the main left bank in the locality of 3,500 to 5,800 feet above bankhead 4 C is marked by a recession of the shore line. This and the approximate course which the channel has followed since last fall are shown on the accompanying map (Plate IV). The extent of bank caving above and below the bankheads in Wilhoites Bend from April 5 to January 27, the date of the last survey, is also shown. There has been some slight caving between 4 C and 5 C since the last survey, but practically none between 5 C and 6 C. In fact, since the completion of the lower radial dike at 5 C in October there has been dead water next to the bank for 1,000 feet downstream, and of late the area of quiet water has widened and extended down to near the head of the pile work at 6 C.

When last examined, June 21, all of the work at the bankheads appeared to be intact, and the conditions generally were very favorable, notwithstanding the stage was 12.2 feet above S. L. W. and a considerable flow from the lower channel.

There was no bank caving going on, though there were indications of recent slight caving about 800 feet above 5 C. The flow past the bankheads was without noticeable eddies. Random soundings indicated an extensive fill below bankhead 6 C. A line of soundings, parallel to the bank between 5 C and 6 C, and about 200 feet from it, indicated a general raising of the bottom to 2 feet above S. L. W. to within 400 feet of the upper end of the pile work at 6 C.

Bankhead 2 C, examined on the 21st of June, was found to be in a very bad con-

dition. The structure had evidently been subjected to a very severe attack by the flood waters. The pave slope and radial curtain work on the upper half of the structure had been scoured out, leaving a square shoulder exposed to the current. As well as could be determined, at such a high stage of river, the 2-row work of the outer wall was intact throughout. Reduced depths of 8 to 23 feet were found inside the outer wall on the upper half of the structure; about 120 feet of the paved slope at the lower end, and all of the radial curtain work on the lower half of the bankhead, appeared to be uninjured.

Dike 3 C, examined the same day, was found intact from the shore to bent 24. Beyond bent 24 the structure has been carried away.

An examination of the Cambridge Bend revetment, made the same day, disclosed a break near the lower end 200 feet in length, and at two other points there were indications of a settlement.

AT NIGGER BEND.

[See accompanying map, Pl. V.]

Project.—The project, approved April 28, for the expenditure of $7,000, allotted from the sundry civil act of March 3, 1899, for work at Nigger Bend, provided for the extension of the old revetment of 1889 downstream as far as the funds would permit, about 700 or 800 feet.

Revetment construction.—Notice of approval of project was received May 1. Measures were at once taken for procuring, by hired labor, the necessary brush and stone, for the purchase of other materials and supplies, and the assembling on the work of floating plant and other tools required.

Between the dates of May 17 and June 3, 738 linear feet of revetment were constructed. The work was done as nearly in accordance with standard specifications as the stage of river permitted. The mattress was woven in one piece 738 feet long and of average width of 90.8 feet. At the upper end it overlaps the mattress of the old revetment of 1889 25 feet, and its inshore edge lies on the 8-foot contour above S. L. W.

In grading the upper bank slope, a low levee about 550 feet in length, lying close to the edge of the bank, was cut out. Its restoration, authorized in your letter of June 6, was completed June 11.

The cost and elements of work are shown in the Appendix, Exhibit I.

Revetment repairs.—A slight settlement in the upper bank work of the old revetment, near its head, was repaired by the expenditure of 45 cubic yards of spawls distributed evenly over about 90 linear feet of bank.

ROCHEPORT REACH.

[See accompanying map, Pl. VI.]

Bankhead, 1 D, pile-work extension and repairs.—This work was done in accordance with approved plans under the allotment for repairs and contingencies.

The extension of this bankhead with pile work, in accordance with approved plans transmitted with your letter of June 14, 1890, was in progress at the close of the last fiscal year, the status of the work at that time being as follows: Sixteen bents of 2-row work on the 1,000-foot curve had been completed except curtaining; the piles for the upper two radial curtains had been driven and braced; 12 bents, or 115 linear feet, of the 2-row radial pile work had been completed, excepting the sinking of its foot mattress and attaching the curtain.

Work was continued until July 2, when high water compelled a suspension. In the two days the foot mattress of the 2-row radial dike was sunk in place and 457 linear feet of curtaining done, leaving uncompleted 40 linear feet of curtain on the outer 2-row work and 90 linear feet on the single-row radials.

Between July 8 and 10, two short spurs of fascines were built, one 49° 22′ below and the other near the line of the new directrix of the bankhead, in order to break up an eddy which had begun to undermine the upper cone work. A thatching of brush, covered with stone, was also placed at the upper and lower ends of the paved slope.

Work was resumed August 17 and again suspended on the 29th on account of great depths of water and swift current. During that time the 2-row work on the 1,000-foot curve was extended 6 bents downstream; the 2-row radial work connected with the outer wall by a single-row pile curtain and the upper two radial curtains completed; the new 2-row work on the 1,000-foot curve was provided with foot mattress, overlapping the old one 57 feet at radial bent 12 and extending downstream 118 feet. The new mattress was made 100 feet wide outside of the 1,000-foot curve from its lower end 61 feet upstream, and narrowed down to a width of 40 feet at its head.

Between October 22 and November 3 a small force was engaged in cutting down to bankhead grades the pile-extension work built during a high stage of river, and completing and repairing the curtain.

In the movement of an ice gorge in Diana Bend, early in January, the pile-extension work at the bankhead was badly damaged. The outer row of piles of the 2-row work on the 1,000-foot curve below the first radial curtain was carried away and the bracing more or less injured. Later on, the radial 2-row work, beyond the seventh bent from shore, and its single-row extension, was destroyed.

Between the 20th and 26th of April the radial 2-row pile work from the shore, one bent beyond the inner line of the berm, was restored and extended. Six new pile bents, eighth to thirteenth inclusive, spaced 10 feet in the rows and the rows 14 feet were driven; the work was double braced from bents 7 to 11, strand ties attached and the dike curtained from shore to bent 13. A plan of the bankhead as extended and repaired accompanies. (Pl. XIII.)

The cost of the extension and repairs is shown in item in the Appendix, Exhibit J.

HUNTSDALE REACH.

[See accompanying map, Pl. VII.]

Project.—The project for the expenditure of $8,450.19, available for the work, provided for the construction of a revetment at the head of the cutting bank just below the accretions formed by the abatis built in December, 1898; the length of the revetment to be as great as the funds would permit, from 700 to 800 feet.

Revetment construction.—Notice of the approval of the project, January 6, was received with your letter of January 10, but it was not until March 25 that the construction of the revetment was commenced. In the interim all of the construction materials and plant were assembled.

Between the dates of March 25 and April 17, 825 linear feet of revetment, as measured on the S. L. W. contour, were constructed.

Standard specifications were conformed to in every respect. Some special work necessitated by a large gully in the bank near the lower end of the revetment added to the cost of the work.

The elements of work and cost are shown in the Appendix, Exhibit K.

The abatis above the revetment, built in December, 1898, are still in good condition, excepting that about 30 to 50 feet of the lower one, near its outer end, appears to have been damaged somewhat. The accretions formed by them have been materially raised during the year and for the most part are covered with a growth of cottonwood, willow, and weeds. During the past two months some caving has occurred near the lower end of the accretions, uncovering the main bank just above the revetment and causing it to cave a little. It is probable that the revetment may on that account have to be extended upstream, but the danger of loss of work from the attack is not imminent.

HOWARDS BEND REACH.

[See accompanying map, Pl. VIII.]

No work was done on this reach, and none was required, the three bankheads having passed through the year without being injured. It is presumed, however, that had funds been available a betterment of conditions of flow at bankhead 6 F would have been undertaken by a pile-work extension of the structure similar to those made to the bankheads in Wilhoites Bend.

The accompanying map (Pl. VIII) shows the situation in Howards Bend, as developed from a survey of October 25 to November 1, and the approximate channel line as it appeared in the examination of the 14th day of June. The latter indicates an important change in the conditions between bankheads 5 F and 6 F, the great bar there when the survey was made, having been scoured out. There has been no bank caving during the year between bankheads 5 F and 6 F, and none of any consequence between 4 F and 5 F. There has been some caving above 4 F, and recently a pocket about 125 feet long has formed in the bank, at its head, causing an objectionable eddy. The flow past 5 F and 6 F was comparatively mild and without eddy.

PELICAN BEND REACH.

[See accompanying map, Pl. IX.]

Project.—As stated in my last annual report, I was notified under date of January 14, 1899, of the approval of the project for the expenditure of $80,000 from the appropriation of $100,000 in the urgent deficiency act of January 5, 1899, for continuing

and completing the work of protecting the bank in Pelican Bend. The project contemplated the extension of the revetment 1,000 feet upstream from the upper end of the old work and as far downstream from the lower end of the old work as the amount available would permit. It was expected that altogether 9,000 or 10,000 linear feet of revetment could be built.

Some preparatory measures, instituted just before the close of the last year, in the way of repairing and outfitting plant, locating and contracting for brush on the stump, and securing a suitable quarry site, were amplified and actively pushed on the opening of the current year.

Revetment construction.—The construction of revetment was commenced August 10 and continued with little interruption until December 27, when operations were suspended on account of ice in the river.

Work was resumed March 9 and finally completed March 30. In all, 8,748 linear feet of revetment were constructed, extending the old revetment 1,007 feet upstream from its upper end and 7,741 feet downstream from its lower end.

Standard specifications were closely followed, but on a section of the work about 2,400 feet in length, joining at its upper end the lower end of the old work, the new mattress was laid on a dry shore bar, its outer edge, except for about 200 feet near the lower end, being from 1 to 2 feet below S. L. W. and the inner edge about 6 feet above.

This portion of the revetment, although built with great care and close attention to detail, may give trouble in the future.

The total length of continuous revetment now in Pelican Bend is 15,198 feet, as measured on the S. L. W. contour.

The elements of work and cost are shown in the Appendix, Exhibit L.

Ice harbor.—For the protection of the floating plant in winter quarters an ice harbor (see accompanying photographic plate, Plate XXV) was made about 1 mile below Musics Ferry on the right bank, by the construction of a sheer dike composed of 4 triangular-shaped piers spread about 30 feet apart, with two intermediate pile clusters in each space. The piers were formed of clusters of 3 piles driven in the angles of an equilateral triangle of 14-foot sides, planked up to S. H. W. with 6 by 8 inch cottonwood, screw-bolted to the piles. Each pier was weighted with about 15 cubic yards of stone, supported on a platform of 6 by 8 inch stuff near the level of the water surface, and further secured with ¾-inch strand ties. At the upper apex of each pier a fender pile was also driven. The piers and intermediate clusters were joined longitudinally with two connecting lines of strand. The upper end of the sheer dike being about 150 feet out from the 6-foot contour of the right bank, a spur dike of riprap stone 115 feet long was built in order to shut off the ice flow through the opening. This dike rests on rock in place, which extends about 175 feet into the river with a dip of about 1 on 15, and is built with a top width of 7 feet to a level of 6 feet above S. L. W.; 290 cubic yards of stone were expended in its construction. The cost of the work was $1,296.09.

PROCURING CONSTRUCTION MATERIALS.

Stone.—During the year, 30,286.78 cubic yards of stone were procured by hired labor. Of this amount 3,176.88 cubic yards were for work at Randolph; 1,729.9 cubic yards on Nigger Bend Reach; 2,082 cubic yards for work near Huntsdale and Rocheport, and 23,298 for Pelican Bend Reach. There were acquired by purchase, under proposals sent out from this office, 3,086.04 tons and 393.4 cubic yards of stone, distributed among the different reaches in quantities as follows:

Lexington Reach:
575.5 tons, at 93 cents, delivered by contractors H. W. Kolkmeyer & Co. on barges near Lexington, Mo.

Glasgow Reach:
1,875 tons, at 94 cents; 434 tons, at 84 cents, and 201.54 tons of spawls, at 45 cents, delivered by contractors H. W. Kolkmeyer & Co. on barges near Glasgow, Mo.
116.6 cubic yards, at $1.10, delivered by contractors Simons & Marr on river bank near Glasgow, Mo.

Nigger Bend Reach:
276.8 cubic yards, at 25 cents, purchased of W. N. Marshall, Lisbon, Mo.

Brush and poles.—These materials were procured by hired labor as required. A total of 9,017.13 cords were procured for the different localities, as follows: Randolph, 618 cords; Little Blue Reach, 748 cords; Lexington, 357.1 cords; Miami, 20.2 cords; Glasgow Reach, 2,024 cords; Nigger Bend, 396.5 cords; Huntsdale, 396.2 cords; Rocheport, 121.5 cords, and Pelican Bend Reach, 4,335.63 cords.

Piling and lumber.—These materials were furnished under informal contract as required, except that a few of the cottonwood piling were acquired by hired labor. In all, 137,942 feet B. M. of lumber and 65,806 linear feet of piling were procured for the different localities, as follows: Little Blue Reach, 26,208 feet B. M. of lumber and 3,630 linear feet of piling; Lexington Reach, 16,085 feet B. M. of lumber and 11,890 linear feet of piling; Glasgow Reach, 68,341 feet B. M. of lumber and 43,38[illegible] linear feet of piling; Miami, 3,520 feet B. M. of lumber and 1,280 linear feet of piling; Rocheport Reach, 2,635 feet B. M. of lumber and 2,603 linear feet of piling; and Pelican Bend Reach, 21,153 feet B. M. of lumber and 3,015 linear feet of piling.

Strand, wire nails, etc., were purchased under usual specifications. A large number of dike bolts, cable clips, and other fastenings were manufactured at the boat and supply yard at Gasconade for use on the detached works. These were shipped to the different localities as required from time to time.

The cost of construction materials is shown in the cost exhibits of the various works on which they were expended.

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Towboat service.—During the year the steam tenders *Sabrina*, *Arethusa*, *Atalanta* and *Melusina*, and chartered steamers *Gasconade* and *John R. Hugo*, were employed on these works, as follows:

The *Sabrina*, placed in commission August 16, was employed two days towing plant and materials from Gasconade boat yard to Jefferson City. She was cleared light from Jefferson City August 19 for Rocheport, Mo., and was retained there until August 23, towing plant and construction materials in connection with the pile-work extension of bankhead 1D. Returning from Rocheport on August 24, with pile driver No. 10 in tow for Jefferson City, she was kept in general service on Gasconade Division until October 25. On October 26 she was cleared with one 100-foot barge in tow for Pelican Bend, where she arrived October 29, and was retained in service thereafter until November 30. She was laid up for the winter in harbor below Musics Ferry. She was placed in commission again March 8, and engaged in general service on that reach until April 2, when she was laid up with balance of fleet below Musics Ferry.

The *Arethusa* was in service on Rocheport Reach July 1 to 8, inclusive. On the latter date she cleared from Rocheport for Gasconade Division work, in which she was engaged until July 15. From July 16 until end of that month she was engaged in towing plant from Gasconade boat yard and Howards Bend to Pelican Bend and in dispatch work. She was employed at Pelican Bend from the 1st of August to the 13th. She was transferred to Rocheport Reach August 14 and remained in service there four days. On August 18 she was transferred from Gasconade to Glasgow Reach, and remained in service there on general construction work until October 17, after which and until October 25 she was engaged in towing plant and materials from Wilhoites Bend to Miami. From October 26 to November 19 she was engaged in moving plant and materials from Wilhoites Bend to Lexington, and was retained in service on the latter reach until December 3, performing such work as was required of her. During the winter she was laid up with the fleet in Sni Chute. On March 20 she was placed in commission and engaged in towing plant from the Sni Chute to Wilhoites Bend and on dispatch duty at the latter place. On April 27 she was cleared for Randolph Bend with a tow of plant. Arriving there April 30, she was kept in general service until the final suspension of operations May 31, and was then laid up with the balance of the fleet at Randolph.

The *Atalanta* was in service from July 1 to 13, inclusive, in Wilhoites Bend. On July 14 she cleared for Gasconade boat yard with a lot of unserviceable property on board. While at the yard some repairs were made to her boiler and engines. From July 20 to the close of the month she was engaged in towing plant from Gasconade to Wilhoites Bend for Little Blue work. From August 1 to 17 she was on the Glasgow Reach performing general service, and cleared on the latter date for Little Blue Reach, where she was engaged until August 25 assembling plant there for work on Omaha Division. She cleared on the latter date with her first tow for St. Joseph, and remained in service on Omaha Division for the balance of the season.

The *Melusina* was placed in commission on July 9, on Little Blue Reach, after undergoing repairs, and cleared for Wilhoites Bend, arriving there July 17. From that date until September she was engaged in towing plant from the latter place to the Little Blue Reach, and performing such other service on that reach as was required of her. From September 10 to October 16 she was in service on the Omaha Division. From the latter date to November 28 she was again in service on the Glasgow Reach and also at Lexington, Mo. She was laid up for the winter in the Sni Chute with

the balance of the fleet. She was again placed in commission April 4, and from that time until June 4, when she was laid up at Cambridge, Mo., was engaged on Randolph, Nigger Bend, and Rocheport reaches in towing plant, construction materials and supplies, and moving plant from one reach to another.

The steamer *Gasconade*, chartered at Jefferson City, September 14, at $25 per day, was employed until November 17 on works pertaining to Omaha Division. On November 21 she returned to Lexington, Mo., and until November 23 was engaged in shifting plant and towing construction materials at that place. From November 24 to 26 she was engaged on work pertaining to the bankheads in Wilhoites Bend. On November 27 she became disabled and was released from service.

The steamer *John R. Hugo* was chartered August 25 at $40 per day for service on Pelican Bend. She remained on that work until December 28, when she was released. The steamer was again in service on March 9, in Pelican Bend, in moving plant from the harbor below Musics Ferry to the left bank of the river. She was again chartered April 3, and cleared for Huntsdale with tow for Randolph. She arrived there April 6 and cleared the next day for Nebraska City.

Repairs to plant.—A part of the plant on these works was repaired in the boat yard at Gasconade, and a statement and cost of the work is given in my annual report of this year for Gasconade Division. Between the dates of March 19 and April 17 the following pieces were repaired at Sni Chute, above Lexington, Mo.:

100-foot barges	6
64-foot barges	8
Mattress boat	1
Pile drivers	2
Double-deck quarter boat	1
Steam tender *Arethusa*	1
Skiffs	8

The work consisted of calking sides and rakes above light-load line and making such other repairs as seemed necessary.

During the month of April a new rudder was constructed for the steamer *Arethusa* at Glasgow, Mo.

Care of plant.—All floating plant in service on the work at the close of operations in the late fall was placed in winter quarters as follows:

In Sni Chute, above Lexington, Mo.:

100-foot barges	6
64-foot barges, with cabins	4
64-foot barges	4
Double-deck quarter boat	1
Pile drivers	2
Steam tenders (*Arethusa* and *Melusina*)	2
Ponton	1
Skiffs	15

Musics Ferry, Pelican Bend:

100-foot barges	13
64-foot barges, with cabins	2
64-foot barges	4
Quarter boats	4
Pile driver	1
Grader	1
Cross boat	1
Mattress boats	2
Steam tender (*Sabrina*)	1

At the close of operations in May and June the detached floating plant assembled at Randolph, Cambridge, and Musics Ferry, that at Randolph consisting of the following hulls:

100-foot barges	3
64-foot barge, with cabin	1
Mattress boat	1
Steam tender (*Arethusa*)	1

At Cambridge:

100-foot barge	1
64-foot barges, with cabins	4
64-foot barges	3

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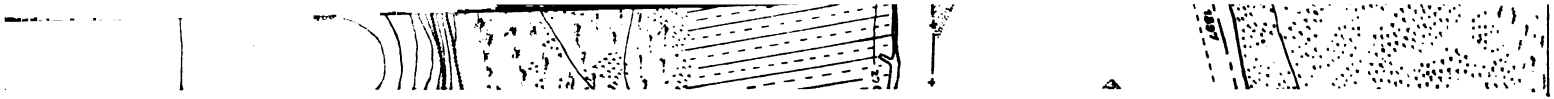
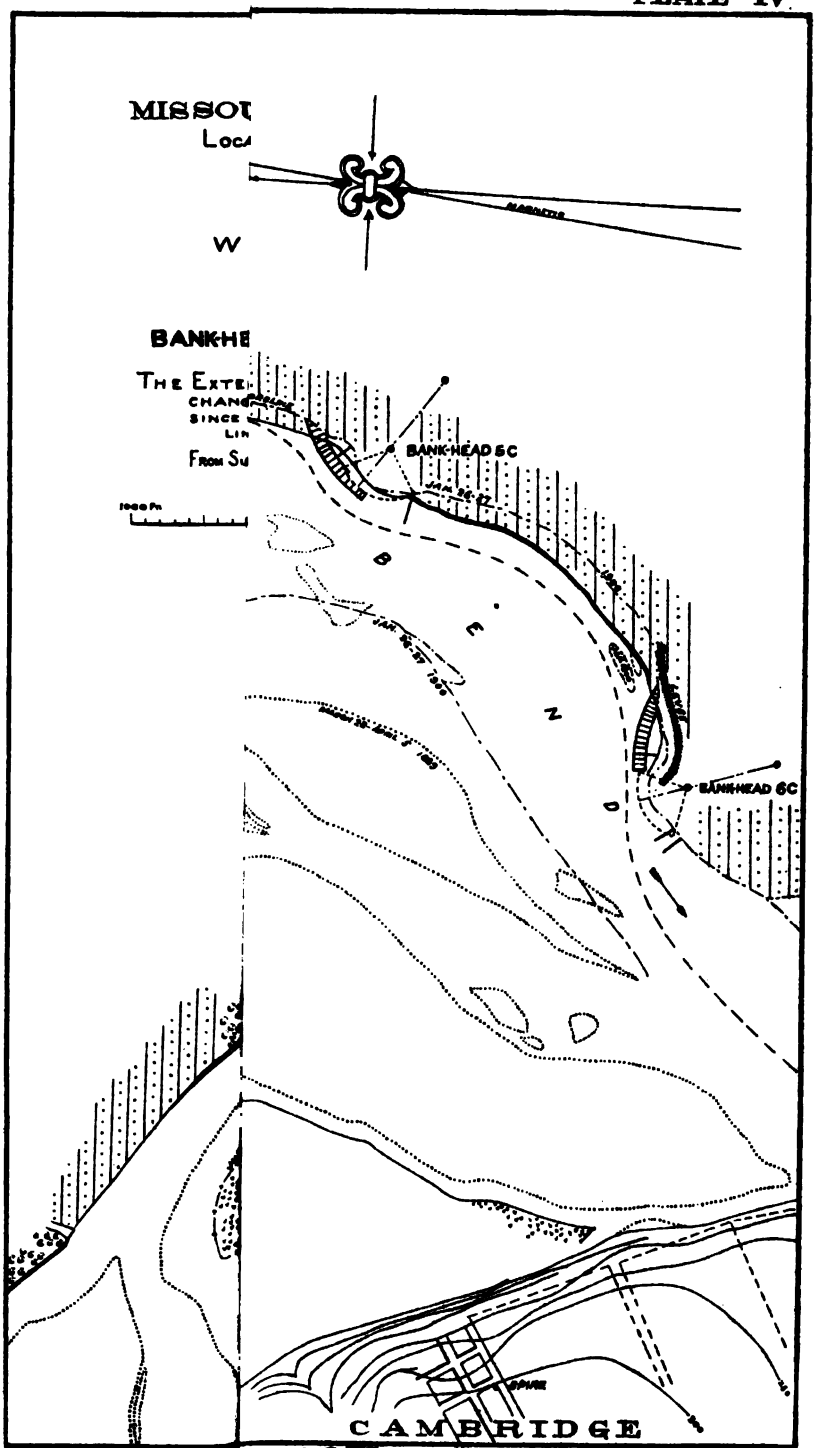


PLATE IV



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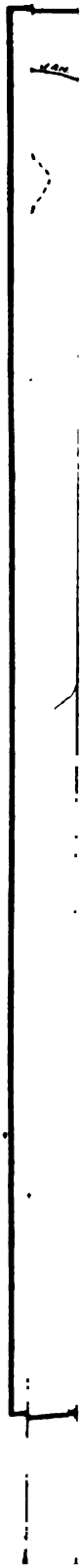

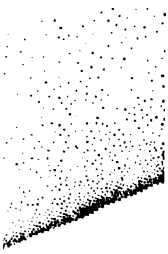

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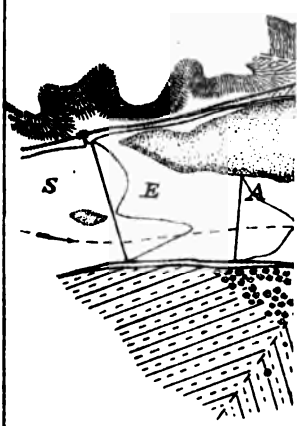

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MISSOURI RIVER COMMISSION.

LOCAL WORKS BELOW KANSAS CITY, MO.

MAP OF

MISSOURI RIVER

VICINITY OF

HOWARDS BEND

ABOVE

ST. CHARLES, MO.

SHOWING

LOCATION OF BANK-HEADS 4F, 5F, AND 6F, COMPLETED DURING FALL OF 1897 AND WINTER OF 1898, AND THE CONDITIONS OF FLOW. ALSO EXTENT OF BANK CAVING SINCE SEP. 1897.

AS DEVELOPED FROM SURVEY OF Oct. 25 Nov. 1 1899.

STAGE + 0.5 Ft. ABOVE S.L.W.

SCALES:

1000 Ft. HORIZONTAL 2000 Ft.

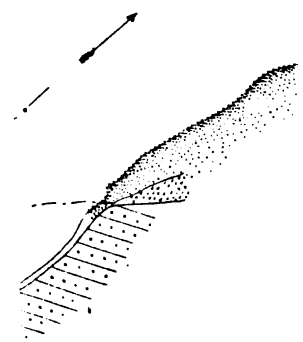
20 Ft. VERTICAL 80 Ft.

NOTE:

SHORELINE SHOWN THUS — — · FROM SURVEY OF SEP. 1897

— · — JUNE 1898

SOUNDINGS REDUCED TO S.L.W.



report for 1900, of S. Waters Fox, Asst. Eng'r

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PLATE XI

BSOURI RIVER COMMISSION.

LOCAL WORKS BELOW KANSAS CITY, MO.

GLASGOW REACH

PLAN

OF

BANK-HEAD 5C.

SHOWING

ARACTER AND EXTENT OF WORK DONE DURING

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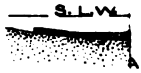
SCALE:



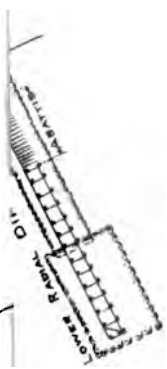


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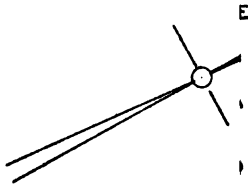
PLATE XIII

COMMISSION

ANSAS CITY, Mo.

EACH.



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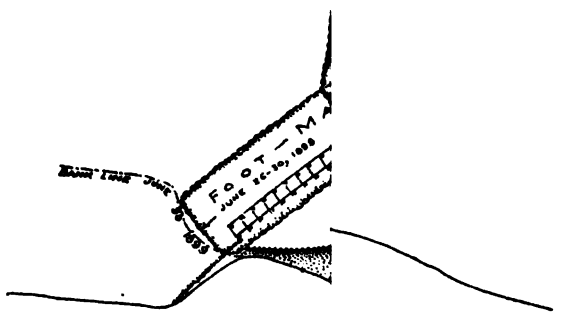

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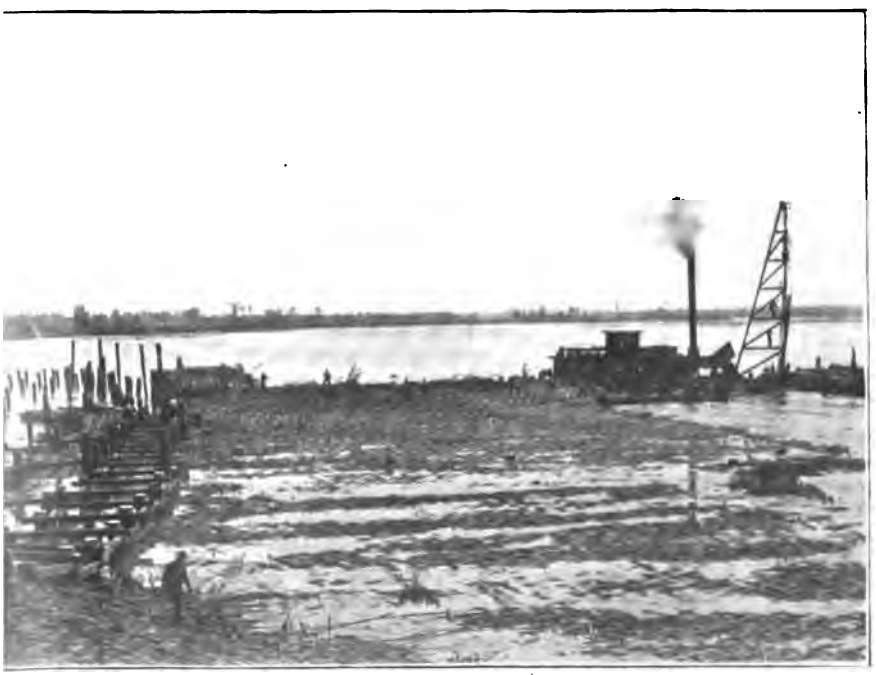
GLASGOW REACH. BANKHEAD 4 C REMODELED. LOOKING DOWNSTREAM FROM BANK ABOVE STRUCTURE. PARTY AT WORK WEAVING MATTRESS AND DRIVING PILES. SEPTEMBER 2, 1899. STAGE, 5.3 FEET ABOVE S. L. W.



GLASGOW REACH. BANKHEAD 4 C REMODELED. LOOKING DOWNSTREAM FROM BANK ABOVE STRUCTURE. PARTY WEAVING MATTRESS. TRACING 2-ROW WORK ON 1,000-FOOT CURVE AND DRIVING ANCHORAGE PILES. SEPTEMBER 7, 1899. STAGE, 4.3 FEET ABOVE S. L. W.

GLASGOW REACH. BANKHEAD 4 C REMODELED. LOOKING DOWNSTREAM FROM BANK ABOVE STRUCTURE. OCTOBER 14, 1899. STAGE, 1.4 FEET ABOVE S. L. W.

GLASGOW REACH. BANKHEAD 4 C REMODELED LOOKING UPSTREAM FROM LOWER RADIAL DIKE. OCTOBER 19, 1899.

LITTLE BLUE REACH. BLUE MILLS ISLAND REVETMENT. LOOKING DOWNSTREAM FROM HEAD OF WORK. LENGTH OF REVETMENT 460 LINEAR FEET. APRIL 3, 1900.

RANDOLPH REACH. RANDOLPH BEND REVETMENT. LOOKING UPSTREAM FROM LOWER END OF WORK. LENGTH 1,200 FEET. JUNE 18, 1900. STAGE 11.3 FEET ABOVE S. L. W.

HUNTSDALE REACH. HUNTSDALE REVETMENT. LOOKING DOWNSTREAM FROM HEAD OF WORK. LENGTH 825 LINEAR FEET. APRIL 14, 1900. STAGE, 5 FEET ABOVE S. L. W.

NIGGER BEND REACH. NIGGER BEND REVETMENT EXTENSION. LOOKING DOWNSTREAM FROM HEAD OF WORK. LENGTH 733 LINEAR FEET. JUNE 4, 1900. STAGE, 8.4 FEET ABOVE S. L. W.

PELICAN BEND REACH. PELICAN BEND REVETMENT. LOOKING DOWNSTREAM. PARTY COMPLETING PAVING OF A 100-FOOT SECTION OF UPPER BANK WORK. NOVEMBER 18, 1899. STAGE, 1.3 FEET ABOVE S. L. W.

PELICAN BEND REACH. PELICAN BEND REVETMENT. LOOKING DOWNSTREAM FROM POINT ABOUT 550 FEET BELOW HEAD OF REVETMENT. PARTY AT WORK WEAVING AND ANCHORING MATTRESS. SEPTEMBER 15, 1899. STAGE, 3.25 FEET ABOVE S. L. W.

PELICAN BEND REACH. PELICAN BEND REVETMENT PARTY PUTTING SPAWLS ON UPPER BANK AT INNER EDGE OF MATTRESS PRELIMINARY TO PAVING. SEPTEMBER 15, 1899. STAGE, 3.25 FEET ABOVE S. L. W.

'EL'CAN BEND REACH. WINTER HARBOR, ' MILE BELOW MUSIC'S FERRY. PILE PIERS IN SHEER DIKE AND STONE SPUR AT HEAD OF HARBOR IN FOREGROUND JANUARY 7, 1900. STAGE, 0.8 FOOT BELOW S. L. W.

G.—Consolidated bill of cost, extension, repair, etc., Bankhead 6 C.
H.—Consolidated bill of cost, extension, repair, etc., Bankhead 4 C.
I.—Elements of work and cost in detail of 738 linear feet revetment, Nigger Bend.
J.—Consolidated bill of cost, extension, and repair, Bankhead 1 D.
K.—Elements of work and cost in detail of 825 linear feet revetment, near Huntsdale.
L.—Elements of work and cost in detail of 8,748 linear feet revetment, Pelican Bend.

EXHIBIT A.

Classified statement of money expenditures under allotments for detached works below Kansas City, Mo., during fiscal year ending June 30, 1900.

	At Randolph Bend, Mo.	Above mouth of Little Blue River.	At Lexington, Mo.	Above Glasgow, Mo.
Actual expenditure on account of construction for labor and materials	$7,753.41	$7,805.68	$5,036.36	$6,834.28
Towboat service while directly engaged in construction	385.78	1,014.58	263.24	1,080.15
Total	8,139.19	8,820.26	5,299.60	7,914.43
All other plant service, including repairs, watching, and moving from place to place	1,750.32	2,084.80	1,515.30	1,205.01
Administration charges, Jefferson City, office and field	1,965.66	1,422.72	949.30	2,138.45
All other charges:				
New plant	.....	92.07	79.37	286.54
Surveys	128.36	65.98	87.60	7.51
Total	128.36	158.05	166.97	294.05
Grand total	11,983.53	12,485.83	7,931.17	11,551.94

	At Nigger Bend, Mo.	Near Huntsdale, Mo.	Pelican Bend and vicinity.	Total.
Actual expenditure on account of construction for labor and materials	$3,629.07	$4,180.54	$61,682.06	$96,921.40
Towboat service while directly engaged in construction	.....	.....	6,281.33	9,025.08
Total	3,629.07	4,180.54	67,963.39	105,946.48
All other plant service, including repairs, watching, and moving from place to place	1,622.12	1,137.82	10,780.61	20,095.98
Administration charges, Jefferson City, office and field	979.79	1,702.72	7,856.04	17,014.68
All other charges:				
New plant	.....	.....	401.49	859.47
Surveys	104.50	110.55	795.72	1,300.22
Total	104.50	110.55	1,197.21	2,159.69
Grand total	6,335.48	7,131.63	87,797.25	145,216.83

a About 73 per cent of grand total expenditures.
b About 14 per cent of grand total expenditures.
c About 12 per cent of grand total expenditures.
d About 1 per cent of grand total expenditures.

EXHIBIT B.

Elements of work and cost in detail of 1,200 linear feet of revetment, Randolph Bend, constructed during May, 1900.

Classification and extent.	Cost in item.	Total.
Grading bank, 1,200 linear feet, containing 6,211 cubic yards of earth:		
Supplies	$51.64	
Labor and subsistence	209.31	
Total cost at $0.042 per cubic yard		$260.95
Construction and anchorage of mattress, 1,207 linear feet, or 103,802 square feet:		
617.79 cords brush	1,454.18	
9,642 pounds ½-inch strand	621.91	
939 pounds cable clips	114.00	
320 linear feet pine piling (deadmen)	17.50	
Labor and subsistence	817.45	
Total cost at $0.029 per square foot		3,025.04
Ballasting mattress and bank, 3,176.88 cubic yards:		
3,176.88 cubic yards stone	2,635.70	
Labor and subsistence	1,356.92	
Total cost at $1.257 per cubic yard		3,992.62
Building levee near head of revetment, 90 linear feet in length, containing 293 cubic yards of earth:		
Labor and subsistence	73.13	
Total cost at $0.25 per cubic yard		73.13
Towage, moving construction parties, their plant, materials and supplies		569.32
All other items incidental to construction		125.22
Grand total cost at $6.70 per linear foot		8,046.28

EXHIBIT C.

Elements of work and cost in detail of restoration of Dike 2 A, Little Blue Reach, during the months of August and September, 1899.

Classification and extent.	Quantity.	Cost.
Piling, cottonwood.....linear feet..	10,806	$755.79
Lumber, long-leaf yellow pine.....feet B. M..	267	5.54
Lumber, cottonwood.....do.....	25,120	298.16
Stone.....cubic yards..	547	492.64
Brush and poles.....cords..	482.5	875.18
½-inch galvanized strand, mooring and lashing foot mattress.....pounds..	3,625	184.69
½-inch galvanized strand, bracing.....do.....	3,658	221.37
Bolts, spikes, nails, cable clips		166.99
Labor and subsistence, as follows:		
Pile driving		896.06
Weaving and sinking		856.06
Bracing		477.12
Curtaining		178.21
Supplies		68.18
Steamboat service: Towing all supplies, etc., construction materials, moving parties and their plant		932.12
All other items incidental to construction		372.62
Total cost		6,780.73

EXHIBIT D.

Elements of work and cost in detail of 460 linear feet of revetment Blue Mills Island, constructed during August and September, 1899.

Classification and extent.	Cost in item.	Total.
Grading bank, 550 linear feet, containing 1,680 cubic yards of earth:		
Supplies	$20.13	
Labor and subsistence	45.02	
Total cost at $0.0388 per cubic yard		$65.15
Construction and anchorage of mattress, 460 linear feet, or 43,314 square feet:		
301 cords brush	520.85	
3,820 pounds ½-inch strand	194.63	
247 pounds cable clips	8.69	
Labor and subsistence	532.45	
Total cost at $0.029 per square foot		1,256.62
Ballasting mattress and bank, 1,290 cubic yards:		
1,290 cubic yards stone	1,077.88	
Labor and subsistence	347.18	
Total cost at $1.105 per cubic yard		1,425.06
Towage, moving construction parties, their plant, materials and supplies		127.44
All other items incidental to construction		266.56
Grand total cost at $6.828 per linear foot		3,140.83

EXHIBIT E.

Consolidated bill of cost of dikes Nos. 1, 2, 3, 4, Lexington Reach, constructed during November and December, 1899, and April, 1900.

Classification.	Dike No. 1.		Dike No. 2.		Dike No. 3.		Dike No. 4.	
	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
Cottonwood piling, linear feet	1,902	$95.10	2,522	$126.10	1,240	$62.00	1,912	$99.12
Cottonwood lumber, feet B. M.	5,048	59.42	7,392	81.06	3,989	43.91	4,736	52.10
Brush and poles, cords	92	170.35	102.7	186.70	60.9	111.34	81.9	154.60
Stone, tons	122	113.43	179.6	167.00	61.1	56.81	102.7	95.49
½-inch strand, pounds	663	54.03	990	80.69	.....	.....	769	62.67
¾-inch strand, do	1,265	52.99	1,892	79.28	848	48.52	1,259	49.54
Bolts, spikes, nails, and cable clips, pounds	1,274	55.22	1,917	81.11	921	39.43	1,260	56.55
Labor and subsistence, as follows:								
Pile driving	.....	98.38	.....	144.78	.....	74.07	.....	92.34
Bracing	.....	135.09	.....	152.59	.....	49.73	.....	83.98
Weaving and sinking	.....	157.52	.....	271.22	.....	113.88	.....	180.16
Curtaining	.....	16.85	.....	27.34	.....	12.47	.....	12.88
Supplies and fuel	.....	6.66	.....	13.08	.....	4.40	.....	7.89
Steamboat service, towing all supplies, etc., construction materials, moving parties and their plant	.....	101.34	.....	137.86	.....	69.29	.....	103.06
All other items incidental to construction	.....	98.04	.....	127.26	.....	58.76	.....	90.75
Total	.....	1,209.42	.....	1,676.07	.....	744.61	.....	1,140.58

Consolidated bill of cost of construction and repair of pile-work extension and lower radial dikes, building nine stone dikes, etc., Bankhead 6 C, Wilhoites Bend, etc.—Continued.

Classification.	Lower radial Dike B construction.		Building nine stone dikes across berm.		Restoring upper cone.		Building reinforce levee.	
	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
Native piling and posts.....number..	87	$83.09						
Cottonwood lumber.....feet B. M..	3,963	48.35						
Stone.....cubic yards..	46.4	53.94	512.4	$602.03	81.1	$95.32		
Brush and poles.....cords..	56.6	121.23						
Galvanized strand.....pounds..	1,825	76.18						
Bolts, spikes, nails, and cable clips.do....	1,098.8	51.86						
Labor and subsistence, as follows:								
Pile driving		68.06						
Weaving and sinking		77.50						
Bracing		116.44						
Curtaining		19.00						
Making and placing fascines		57.96						
Building stone dikes				175.68				
Restoring upper cone						85.71		
Building levee								$68.94
Supplies and fuel		5.20						
Steamboat service, towing all supplies, etc., construction materials, moving parties and their plant		180.50		110.00		18.33		
All other items incidental to construction		135.37						
Total, aggregating $14,415.73		1,094.68		887.71		199.36		68.94

EXHIBIT H.

Consolidated bill of cost of construction and repair of pile-work extension and lower radial dike, Bankhead 4 C, Wilhoites Bend, during the fiscal year ending June 30, 1900.

Classification.	Pile-work extension construction.		Reinforcement and repairs of pile-work extension.		Lower radial dike construction.		Repairs to lower radial dike, 60 linear feet of abattis.	
	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.	Quantity.	Cost.
Native piling and posts.....number..	282	$518.03			45	$82.65	15	$0.90
Cottonwood lumber.....feet B. M..	10,868	148.66	576	$7.03	2,448	33.48	192	2.34
Stone (recovered, no cost).cubic yards..	386				48.3			
Stone.....do....	337.9	300.72					8	10.70
Brush and poles.....cords..	512	961.28			45.8	86.00	4	8.57
¼-inch galvanized strand.....pounds..	13,596	766.65	815	46.86	425	24.00	438	23.78
Bolts, spikes, nails, and cable clips, pounds	4,714.4	177.08	223	6.76	472	17.64	169	6.82
Labor and subsistence, as follows:								
Pile driving		411.82				65.76		
Weaving and sinking		1,302.31				119.63		
Bracing		410.10		60.18		102.40		
Curtaining		193.67				35.40		
Constructing abattis								36.56
Supplies and fuel		33.06				5.41		
Steamboat service, towing all supplies, etc., construction materials, moving parties and their plant		510.58				81.45		24.13
All other items incidental to construction		460.58		8.49		67.93		52.91
Totals, aggregating $7,212.32		6,194.54		129.32		721.75		166.71

EXHIBIT I.

Elements of work and cost in detail of 738 linear feet of revetment in Nigger Bend during the fiscal year ending June 30, 1900.

Classification and extent.	Cost in item.	Total.
Procuring 2,008.7 cubic yards of stone:		
Quarry privilege	$86.50	
Explosives	93.86	
Labor	1,115.55	
Total cost at $0.6457 per cubic yard		$1,295.9
Procuring 396.1 cords of brush:		
Stumpage	39.61	
Towage	18.20	
Subsistence	6.00	
Labor	642.69	
Total cost at $1.78+ per cord		906.5
Grading bank, 750 linear feet, containing 32,075 cubic yards of earth:		
Supplies	16.90	
Subsistence	14.01	
Labor	85.06	
Total cost, at $0.0361 per cubic yard		115.9
Construction and anchorage of mattress, 738 linear feet, or 66,992 square feet:		
¾ inch strand, 6,194 pounds	374.12	
Cable clips, 360	18.00	
Pine piling (dead men) 180 linear feet	4.50	
Subsistence	9.38	
Labor	446.04	
Total cost at $0.0127 per square foot		852.0
Ballasting mattress and bank, 2,006.7 cubic yards of stone:		
Subsistence	6.88	
Labor	562.28	
Total cost at $0.2836 per cubic yard		569.1
All other items incidental to construction		106.7
Grand total cost of 738 linear feet of revetment at $4.94+ per linear foot.		3,646.4

EXHIBIT J.

Consolidated bill of cost of pile-work extension and repair bankhead 1 D, Rocheport Reach during the fiscal year ending June 30, 1900.

Classification.	Pile-work extension.		Repairs.	
	Quantity.	Cost.	Quantity.	Cost.
Cottonwood piling.....linear feet..	828	$127.34	620	$30.6
Yellow-pine lumber.....feet B. M..	832	35.20	.....	.....
Cottonwood lumber.....do....	.....	.....	2,231	25.5
Stone.....cubic yards..	133	137.04	12	11.7
Brush and poles.....cords..	141.1	234.64	15	28.5
Galvanized strand.....pounds..	3,111	91.35	830	48.5
Bolts, spikes, nails, and cable clips.....do....	1,573	32.45	815	30.
Labor as follows:				
Pile driving	.....	161.96	.....	49.5
Weaving and sinking	.....	414.74	.....	.....
Bracing	.....	196.07	.....	77.7
Curtaining	.....	111.21	.....	16.
Constructing fascine spurs	.....	.....	.....	53.5
Supplies and fuel	.....	15.75	.....	7.5
Steamboat service, towing all supplies, etc., construction materials, moving parties and their plant	.....	365.53	.....	.....
All other items incidental to construction	.....	131.25	.....	41.7
Total aggregating $2,476.80	.....	2,054.53	.....	422.7

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have brought about and maintained the condition required—i. e., the contraction and maintenance of a channel of a width necessary to give the required depth.

The exception noted is at Kirkman's, where the dam was improperly located, and in consequence the chute has filled up, the dam broken, and has been partly removed by steamboatmen. This point is at present the worst obstruction between the lock and Tuscumbia, 65 miles above the mouth. Even in this case it is probable that the dam could be reconstructed at a cost not to exceed $2,000.

To illustrate the above remarks, sketches are submitted herewith showing the conditions at Burd's, Round Bottom, and Dixon's shoals as shown by surveys made in 1872, before the dams were built. The dams are located on these sketches from records made at the time they were built. (Pls. I and II.)

There are also sketches of the same shoals made from the surveys of 1895, showing the dams as found at that time, also the condition of the shoals. These three shoals are selected as examples because they are the oldest dams built with the exception of the one at Shipley's, and as that will be submerged by the construction of Lock and Dam No. 1 it has not been considered.

At Burd's 2,640 feet of training dam and 440 feet of cross dam were built in 1873, all on the right side of the channel. This was repaired by the use of 800 yards of rock in 1874. In 1879 and 1880, 195 feet of cross wall and 950 feet of training wall were built on the left side of the channel, and since that time no repairs have been made. The sketches show an increase in the ruling depth of a little over 1 foot and no shoaling in the channel below the dam.

At Round Bottom 1,200 feet of training dam and 480 feet of cross dam were built in 1873, and I have found no records of any repairs having been made to it. The survey of 1895 shows the dam intact as to position and length, though the lower end has either been degraded somewhat or has settled. The ruling depth has been increased by 1.5 feet, with no sign of shoaling below the dam.

At Dixon's 583 feet of cross dam and 2,003 feet of training dam were built in 1873, and, with the exception of a break 60 feet long in the cross dam repaired in 1878, it has had no repairs or extensions. The ruling depth has been increased by 1.5 feet. The dam is intact, though the cross dam has been degraded somewhat, and there is not the slightest indication of any shoaling below the dam.

These sketches also show the stability of the stream and its banks.

Results at Moore's Flat, Hoskin's, and Berry's show equally as favorably, though the dams are of more recent construction, and, in the case of Moores Flat, have received more repairs.

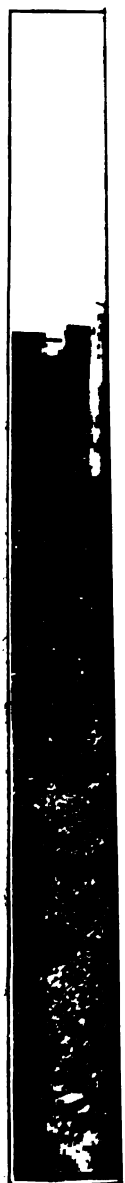
A consideration of the above facts would seem to warrant the assertion that a radical and permanent improvement of the Osage River is possible at a cost insignificant when compared with the cost of canalization, and well within the limit warranted by the commerce and the needs of the country through which the stream flows.

In addition to the above-mentioned works the work of removing snags, logs, stumps, and other obstructions from the channel and cutting overhanging trees from the bank has been carried on at various times since the inception of the work. The latest snagging was done in 1895. More or less of this work will always have to be done, though the amount required will probably not exceed $2,500 per annum.

CONSTRUCTION OF LOCK AND DAM NO. 1.

A history, description, and discussion of this structure is given in the report of the Chief of Engineers for 1897, page 3947, and a report of its partial construction in the report of same for 1898, page 3541. Owing to lack of funds no work had been done from the suspension of operations in 1897 up to the spring of 1899. The river and harbor act of March 3, 1899, having contained a provision for completing the work, a contract had been entered into with Pollard & Wallace, May 16, 1899. The work contemplated in the contract was the completion of the lock walls, constructing the gates, filling behind the land wall, dredging above and below the lock, paving the adjacent slopes, and constructing the dam. The latter is a concrete, iron, and wood structure, resting on a pile foundation. It is 840 feet long between the lock wall and the abutment and is 16 feet high. It is divided by nine piers, each 10 feet thick, into ten sections, each 75 feet in length. The lower 9 feet of its height is stationary and of concrete, with the usual timber apron below it. The upper 7 feet is movable and of the type known as the "Chittenden drum weir." The valves for controlling the ingress and egress of water to the chamber under the weir are situated in the piers. These valves are moved by hydraulic engines, which are in turn actuated through small pipes buried in the concrete by a small pump on shore.

Two drawings are submitted herewith showing the details of construction of the lock and dam. (Pls. III and IV.)



The piles under sections 1, 2, and 3 were driven with a drop hammer. Those under the other sections were driven with a No. 1 Cram steam hammer. Section 10 and the abutment rest on solid rock.

Piling was paid for per foot under the cut-off.

The piles are capped with 10 by 10 inch yellow pine and floored over with 3-inch oak.

The concrete stationary dam and the steel frames supporting the weir are placed on this floor. The dam is 9 feet high, 11.5 feet wide on the bottom; the downstream face is vertical to the full height and forms one side of the passage through which the water reaches the weir chamber; the upstream face has a vertical height of 4 feet and then slopes downstream till a top width of 2 feet is reached.

A part of the steel work is buried in the concrete.

STEEL FRAMES.

The frames forming the weir, its supports, and the weir chamber are made of the usual commercial shapes of structural steel and are riveted together. This portion of the dam is intended to be entirely self-sustaining, and it depends on the concrete portion only for its weight in preventing overturning of the structure as a whole. Each member was designed and proportioned to resist the strains to be brought on it and has been built in accordance with modern practice in structural work. Each frame forms an independent member, joined to the adjacent ones only by the sheeting which covers the whole.

The steel work was manufactured by the Kenwood Bridge Company, of Chicago. The downstream leg of the A frame carries a bulkhead, which, with the face of the concrete, forms a passage for the water to the weir chamber from the inlets in the piers. In order that the pressure of the water may be uniformly distributed under the weir for its whole length, the connection between this passage and the weir chamber is made through a narrow slit extending the whole length of the latter and having an area about the same as the inlet passages in the piers.

The stationary portion of the dam, the apron, the weir chamber, and the piers of that part of the work which was inclosed as mentioned above was completed about December 5, and as it was not thought advisable to attempt to close the remaining space in the river at that time of the year work was suspended on the 9th for the season.

The weir frames were hung in position and their top surface covered to prevent the accumulation of sediment in the weir chamber during the high-water season.

The work accomplished by contract during the season includes the completion of the lock walls and gates, the removal of the cofferdam surrounding the lock, paving the slopes above and below the lock to an elevation of about 113, the construction of seven sections of the stationary portions of the dam, with the apron and hanging the weir frames in position, seven piers, and the abutment. The amount and cost of each class of work is given in the table attached.

During the season the following was accomplished by hired labor and the purchase of material in open market: Filling valves placed in position in upper miter-sill wall, miter sills constructed in position, gate anchorages placed, controlling valves for dam constructed and hung in the completed piers and the abutment, and the hydraulic engines procured.

There remains yet to be done to complete the structure the erection of three sections of dam and two piers complete, the sheathing of all the weir frames, the installation of the manipulating machinery, the construction of the operating machinery for the gates and the filling valves, filling behind the lock wall, and probably some dredging below the lock.

The amount of work under the various items of the contract, in the completed work and the work yet to do, vary somewhat from the estimated amount as given in the specifications and invitations for proposals, and especially in the amount of excavation. Giving this fact for a basis, the contractors have applied for a termination of their contract, and, after considerable discussion and the rejection of numerous claims, an agreement has been reached with them that contemplates the termination of their contract. They are to be paid for the full amount of work completed and accepted at contract prices, material on hand and required in the completion of the work will be purchased of them at market prices, and the Government is to have the use of their plant for completing the work, for the use of which they are to be paid $2,500. The contractors are to retain their ownership in the plant and remove it on the completion of the work.

Notice of the final approval of this agreement and termination of the contract was received on June 12, and arrangements have been instituted for the completion of the work by hired labor.

Informal proposals have been received and orders given for nearly all of the material required, and it is expected that a small force will be employed by the end of the fiscal year in doing such work as can be undertaken before the river falls to a low enough stage to permit of work in the river. Plates V to XI (photographs) illustrate the progress of the work during the season of 1899.

Very respectfully, your obedient servant,

F. B. MALTBY, *Assistant Engineer.*

Capt. CHARLES KELLER,
Corps of Engineers, U. S. A.,
Secretary Missouri River Commission.

Total quantities of work on the construction of Lock and Dam No. 1, Osage River, Missouri, under contract with Pollard & Wallace dated May 16, 1899.

Designation.	Amount.	Cost.
Earth excavation:		
Wet, at 80 cents per cubic yard	6,356	$5,086.40
Dry, at 70 cents per cubic yard	10,902	7,631.40
Rock excavation, at $1 per cubic yard	1,961	1,961.00
Stone paving, at $1.40 per square yard	693.6	971.04
Cement, at $2.95 per barrel of 380 pounds net	4,428.5	13,064.07
Mortar mixing, forming, and placing, at $5 per cubic yard	76	380.00
Concrete mixing, forming, and placing, at $4.50 per cubic yard	4,447.8	20,015.10
Ironwork:		
Frames, at 6½ cents per pound	220,632	14,341.08
Castings, at 15 cents per pound	35,378	5,305.95
Piles, at 50 cents per linear foot	18,274	9,137.00
Sheet piling, 10 inches wide, at 50 cents per linear foot	15,086	7,543.00
Lumber:		
Floors and aprons, at $46 per M., B. M.	126,526	5,820.20
Sheathing, at $63 per M., B. M.	47,979	3,022.68
Grillage, at $37 per M., B. M.	113,370	4,194.69
Lock gates, at $1,500 each	4	6,000.00
Removing old coffer dam, at $2 per foot	724	1,448.00
Total		105,921.61

APPENDIX G.

ANNUAL REPORT ON THE GASCONADE RIVER, BY MR. F. B. MALTBY, ASSISTANT ENGINEER.

MISSOURI RIVER COMMISSION,
St. Louis, Mo., April 20, 1900.

CAPTAIN: I have the honor to submit the following report of operations pertaining to the improvement of the Gasconade River for the fiscal year ending June 30, 1900:

Owing to a lack of funds, no active field operations had been undertaken since the summer of 1896. An examination of the stream from Arlington to its mouth, a distance of 108 miles, was made in the fall of 1897, and the results of this examination with the recommendations of the officer in charge are given in the report of the Chief of Engineers for 1898.

The river and harbor act of March 3, 1899, contained an item of $15,000 for "Improving the Gasconade River, Missouri," and on May 16, 1899, I was placed in local charge of the work.

The work contemplated for the season of 1899 was of the same general nature as that prosecuted in previous years, viz, the removal of snags and other obstructions from the channel and the construction of contraction works for the purpose of deepening the water over the shoals. The nature of these contraction works, their history, and the results obtained have been discussed in my report of operations on the Osage River for this year, and as the characteristics of the Osage and Gasconade rivers, as far as shoals are concerned, are very similar, the same remarks and conclusions will apply to the works on the latter stream.

No floating plant being available for use on this stream, two gunwale barges were built on the private boat ways at Osage City. They are 68 feet long, 18 feet wide, and 3½ feet deep, with flush deck, and are built of yellow pine throughout. They were built by hired labor and the purchase of material under informal contract.

Cost (2)

Labor	$935.90
Oakum, cotton, paint, and oil	75.83
Iron	112.18
Lumber	776.78
Rental of ways	20.00
	1,920.79

A party of about fifteen men was organized July 24 under the immediate supervision of Mr. S. F. Crecelius, assistant engineer, and work begun at Browns Shanty, or Catfish Shoal, 16 miles from the mouth of the river.

BROWNS SHANTY.

The work at this point consisted of building a low dam running diagonally downstream from the high gravel bar adjoining the left bank and closing two channels across this bar, which together carried about one-half of the low-water discharge. This dam for the greater part of its length was built in very shallow water, and consists simply of a layer of willows about 6 inches thick, on which was placed a loose rock dam averaging about 6 feet wide, 2 feet high, and 1 foot above low water. Where the dam crossed the side channels mentioned above, cribs made of rough logs and about 20 feet long, 5 feet wide, 3 to 6 feet high, and filled with rock were used. At the lower end of the shoal a training wall 245 feet long was built. This wall is not connected with the cross dam. The total length of dam built was 1,075 feet.

A large bowlder about 20 feet long and known as Catfish Rock, which obstructed the channel, was blown to pieces and removed.

Near the lower end of the shoal and opposite the short training wall a small bar projected into the channel from the right bank. This bar was composed of very coarse gravel and was partly scraped away in order to straighten the channel.

The work at this shoal is not considered complete, but as the results obtained were immediate and satisfatory, the depth in the channel being increased from 6 inches to about 2 feet, and as work in other localities was urged by the steamboat men, it was thought best to let it stand in its present condition through one season.

It is proposed to extend the training wall downstream 500 feet and upstream to a junction with the cross dam, and strengthen the cross dam if found necessary.

WOODPECKER ISLAND.

[11 miles above the mouth.]

At this point some fifteen years ago a dam was built from the left bank to what was then the head of Woodpecker Island, thus cutting off the flow from the left-hand chute. Since that time the head of the island has worn away and is now a gravel bar with two channels across it returning the water to the left bank below the old dam. A portion of the latter had been removed by steamboat men and the channel in use was down along the left bank. Work was commenced here August 24 and consisted of removing about 75 feet of the old dam and the construction of a low dam running diagonally downstream from the right bank to the outer end of the old dam, thus shutting off the flow down the right-bank channel. A training dam 315 feet long was built from the inner end of the old dam downstream. The total length of the dam built was 1,175 feet, average height 2½ feet, and average width 6 feet.

The results obtained were immediate and satisfactory, there being not less than 2 feet in the channel. To make the work permanent and complete the training dam should be extended upstream 500 feet and downstream to a junction with a dam built in 1896.

Work was completed September 26 and the party moved to—

BRANDTS SHOAL

[15 miles above the mouth].

At this point, in 1895, there had been built a dam closing the chute along the left bank and behind a small island, and also two spur dikes extending into the stream, one from the island and one from the right bank and somewhat below the first one.

The condition at the beginning of the low-water season of 1899 emphasizes the utter inexpediency of contracting the channel by spur dikes alone. There was no lack of water at this point, but the current whipped around the end of the upper dike

and ran parallel to and below it, making a channel too crooked to navigate. The current around the end of the dike was also excessive, as was to be expected.

The work done consisted of building a new dam across the head of the chute, constructing 375 feet of training dam, and removing 45 feet of the outer end of the old spur dike. The total length of dam built was 445 feet.

The beneficial effects of the work were apparent immediately, but to make them permanent the training wall should be extended upstream to the cross dam. It may be found desirable to extend it downstream also, if the next low-water season shows any indication of a disposition to shoal below.

At upper Turnpike Shoal, about one-half mile below Brandts, the river follows a bend in the right bank, the lower part of the bend being at the foot of a steep bluff. In the bight of the upper end of the bend is a small island, the river side of which is in the general line of the right bank. The chute back of it contained some running water. The water in the channel striking a rocky point formed by the intersection of the right bank and the lower side of the chute, caused an eddy which was a menace to navigation, especially by rafts. A short dam was built across the head of the chute and a training dam from the foot of the island to the main bank making, in effect, a continuous curved bank. The total length of dam built was 470 feet. A large bowlder was also destroyed and removed.

The work at this point was completed October 21, and the work of clearing the channel of snags and other obstructions was begun.

SNAGGING.

The party proceeded to Pryors Bend and from that point worked toward the mouth of the river, removing all snags from the channel. The latter point was reached December 7, and the party discharged.

The river distance worked over was 35 miles and the number of snags removed was as follows:

Length 80 to 85 feet, average diameter 28 inches	13
Length 70 to 80 feet, average diameter 26 inches	9
Length 60 to 70 feet, average diameter 21 inches	18
Length 50 to 60 feet, average diameter 18 inches	27
Length less than 50 feet, average diameter less than 18 inches	115
Large stumps	46
Total	228

In addition, 3 large bowlders and 2 rack heaps were destroyed with dynamite. Counting bowlders and rack heaps each equivalent to one snag, gives a total of 223 snags destroyed. The total field cost of snagging was $1,232.95, or $5.24 per snag.

The field cost of the season's work is shown in the following table:

Construction of barges	$1,795.08
Snagging	1,232.95
Expenditures at Catfish Shoal	1,088.87
Expenditures at Woodpecker Island	1,130.42
Expenditures at Brandts Shoal	843.77
Superintendence and general expenses	1,013.76
Total	7,104.85

Sketches are submitted herewith showing the work accomplished at each of the above shoals (Pls. I, II, and III).

Very respectfully, your obedient servant,

F. M. MAILTBY, *Assistant Engineer.*

Capt. CHARLES KELLER,
Corps of Engineers, U. S. A., Secretary Missouri River Commission.

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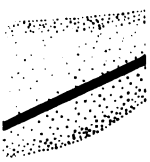

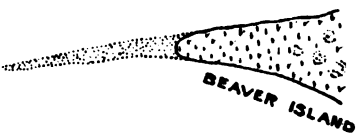

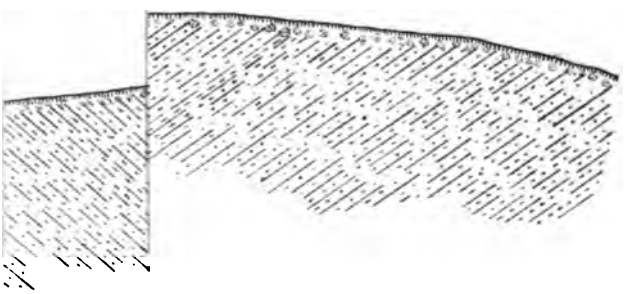

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INDEX.

[The references in roman are to part (or volume) and those in arabic to page.]

A.

Abrams Creek, Tenn., survey of ..... I, 469
Acts of Congress. *See* Laws.
Acushnet River, Mass. *See* New Bedford Harbor.
Agate Bay, Minn., improvement of harbor ..... I, 513; V, 3551
Ahnapee Harbor, Wis., improvement of ..... I, 527; V, 3674
Aid to injured employees, recommendation regarding ..... I, 44
Alabama River, Ala., improvement of ..... I, 340; III, 2132
Albemarle and Chesapeake Canal, N. C., improvement of waterway via ..... I, 262; II, 1778
Albemarle Sound, N. C.:
  Examination of waterway from South Mills to and including Beaufort and Ocracoke inlets ..... I, 265, 277
  Improvement of waterway to Norfolk, Va., via Currituck Sound ..... I, 262; II, 1778
  Improvement of waterway to Norfolk, Va., via Pasquotank River ..... I, 261; II, 1778
Alburg, Vt., bridge across Lake Champlain ..... I, 697
Alexandria Harbor, La.:
  Bridge across Red River ..... I, 698
  Examination and survey ..... I, 414; IV, 2569
  Improvement of Red River below Fulton, Ark ..... I, 398; IV, 2480
Alice (bark), removal of wreck of ..... I, 383; III, 2282
Allegheny River, Pa.:
  Bridge from Highland Park, Pittsburg, to Sharpsburg ..... I, 699
  Construction of locks and dams ..... I, 483; V, 3257
  Improvement by open-channel work ..... I, 485; V, 3263
  Improvement of Pittsburg Harbor ..... I, 481; V, 3254
Alligator Creek or River, S. C.:
  Examination and survey to Charleston ..... I, 292; III, 1908
  Examination and survey to Estherville-Minim Creek Canal ..... I, 291; III, 1894, 1897
Alligator Head, Matagorda Bay, Tex., examination of harbor at ..... I, 397; IV, 2462
Allouez Bay, Wis. (*see* Duluth Harbor) ..... I, 514; V, 3554
Alloway Creek, N. J., improvement of ..... I, 203; II, 1583
Alpena Harbor, Mich., improvement of ..... I, 575; VI, 3975
Altamaha River, Ga., improvement of ..... I, 298; III, 1939
Alvena (steamship), removal of wreck of ..... I, 166; II, 1471
Alviso Harbor, Cal., improvement of ..... I, 624; VI, 4213
Ambrose Channel, New York Harbor, N. Y., improvement of ..... I, 161; II, 1459
Amite River, La., improvement of ..... I, 363; III, 2243
Amphlet Slough, San Joaquin River, Cal., examination for closure of ..... I, 634
Anclote River, Fla., improvement of ..... I, 324; III, 2028
Andura (Nandua) Creek, Va., improvement of ..... I, 260; II, 1771
Ann, Cape, Mass.:
  Construction of harbor of refuge in Sandy Bay ..... I, 72; II, 1161
  Examination and survey of piers and breakwater at Rockport ..... I, 77; II, 1177, 1178
  Resurvey and estimate of cost at breakwater, Sandy Bay, including project for completing harbor of refuge ..... I, 77; II, 1184
Antioch, Cal., examination of channel to Suisun Point ..... I, 634
Apalachicola Bay and River, Fla.:
  Improvement of bay ..... I, 329; III, 2091
  Improvement of river, including the Cut-off ..... I, 330; III, 2095
Appomattox River, Va.:
  Examination of ..... I, 265
  Improvement of ..... I, 258; II, 1766
Appoquinimink River, Del., improvement of ..... I, 211; II, 1633
Aqueduct Bridge, Washington, D. C., repair of ..... I, 703; VIII, 5123
Aransas Pass, Tex., improvement of ..... I, 392; IV, 2336
Arcadia, Mich., examination at ..... I, 569; V, 3942
Arch Rock, San Francisco Harbor, Cal., removal of ..... I, 625; VI, 4215

Arkansas River:
Examination and survey ..... I, 424
Gauging (*see* Mississippi River) ..... I, 412; IV, 2540
General improvement ..... I, 416; IV, 2581
Removal of obstructions ..... I, 415; IV, 2577
Armament. *See* Fortifications.
Arthur Kill, N. Y. and N. J.:
Examination and survey ..... I, 188; II, 1525, 1527
Improvement of (*see* Staten Island-New Jersey channel) ..... I, 178; II, 1502
Arthur Lake, La. (*see* Mermentau River) ..... I, 374; III, 2264
Ashland Harbor, Wis., improvement of ..... I, 516; V, 3592
Ashley River, S. C., examination of ..... I, 292
Ashtabula Harbor, Ohio:
Improvement of ..... I, 600; VI, 4075
Water levels ..... I, 715; VIII, 5402
Assawaman Bay, Del., improvement of waterway via ..... I, 217; II, 1642
Assistance to injured employees, recommendation regarding ..... I, 44
Assistants, civilian, to certain engineer officers ..... I, 35
Assonet River, Mass., examination of ..... I, 111; II, 1300
Astoria, Oreg. (*see* Columbia River, below Tongue Point) ..... I, 670; VI, 4360
Atchafalaya Bay and River, La.:
Examination and survey of bay ..... I, 383; III, 2282, 2284
Rectification of river mouth by Mississippi River Commission ..... I, 694; VII, 4525
Augusta, Ga.:
Improvement of Savannah River above ..... I, 296; III, 1930
Improvement of Savannah River below ..... I, 294; III, 1928
Aux Becs Scies Lake, Mich. (*see* Frankfort Harbor) ..... I, 565; V, 3925

B.

Back Cove, Portland, Me. (*see* Portland) ..... I, 60; II, 1097
Bagaduce River, Me., improvement of ..... I, 51; II, 1084
Baltimore and Ohio Railroad Company, bridge of ..... I, 699
Baltimore Harbor, Md.:
Defenses of ..... I, 6, 11, 21, 866
Harbor lines in Patapsco River, Curtis Bay, and ..... I, 40; II, 1693, 1697
Improvement at Spring Garden ..... I, 233; II, 1693
Improvement of channel to ..... I, 231; II, 1687
Improvement of channel to Curtis Bay ..... I, 233; II, 1692
Removal of wreck in Patapsco River ..... I, 234; II, 1693
Bar Harbor, Me.:
Construction of breakwater ..... I, 47; II, 1079
Defenses of ..... I, 13, 733
Barnegat Light, N. J., removal of wreck off ..... II, 1588
Barren River, Ky., operating and care of locks and dams ..... I, 511; V, 3516
Bartholomew Bayou, La. and Ark., improvement of ..... I, 404; IV, 2513
Bass River Harbor, Mass., examination of ..... I, 110; II, 1282
Bastrop Bayou, Tex., examination and survey ..... I, 395; IV, 2414, 2416
Bath, Me.:
Improvement of Kennebec River at ..... I, 58; II, 1095
Removal of wreck in Kennebec River at ..... I, 62; II, 1100
Battalion of Engineers ..... I, 86, 1050
Batteries:
Dynamite ..... I, 10, 35
Gun and mortar ..... I, 6, 7, 35
Battery, the, New York Harbor, N. Y., removal of wreck off ..... I, 166; II, 1473
Bay Ridge Channel, New York Harbor, N. Y., improvement of ..... I, 163; II, 1464
Bay Shore, Long Island, N. Y., examination at ..... I, 160; II, 1441
Bayside Channel, New York Harbor, N. Y., improvement of ..... I, 161; II, 1459
Beachridge, Ill. *See* Beechridge.
Beach Thoroughfare, N. J., examination of ..... I, 208
Bears Cut, Biscayne Bay, Fla., examination of ..... I, 316; III, 1986
Beaufort Harbor and Inlet, N. C.:
Defenses of harbor entrance ..... I, 23, 897
Examination of waterway from South Mills to and including Beaufort Inlet ..... I, 265, 277
Improvement of harbor ..... I, 271; III, 1808
Improvement of waterway from Beaufort to Newbern ..... I, 270; III, 1806
Improvement of waterway from Beaufort to New River ..... I, 271; III, 1810

Beaufort Harbor and River, S. C.:
Defenses of Port Royal Sound ..... I, 6, 10, 12, 24, 915
Improvement of channel to Savannah, Ga. (*see* Savannah) ..... I, 292; III, 1913
Improvement of river ..... I, 289; III, 1873
Removal of sunken logs in waterway to Charleston ..... I, 291; III, 1876
Removal of wreck of boat *Sprite*, near naval station ..... I, 290; III, 1875
Beechridge, Ill.:
Examination and survey for preventing break in Mississippi River at ..... I, 431; IV, 2672, 2674
Prevention of break in Mississippi River at ..... I, 429; IV, 2666
Belle River, Mich., improvement of ..... I, 582; VI, 3991
Bellevue, Iowa, examination of Mississippi River opposite ..... I, 434; IV, 2759
Bell, Lavinia (schooner), removal of wreck of ..... I, 62; II, 1100
Benson (schooner), removal of wreck of ..... I, 603; VI, 4094
Benton County, Oreg., bridge of ..... I, 701
Benton Harbor Canal, Mich. (*see* St. Joseph Harbor) ..... I, 552; V, 3879
Bergen County Traction Company, bridge of ..... I, 700
Beverly Harbor, Mass., examinations of ..... I, 77, 78; II, 1182
Big Assawaman Bay, Del., improvement of waterway via ..... I, 217; II, 1642
Big Barren River, Ky., operating and care of locks and dams ..... I, 511; V, 3516
Big Richland Creek or River, Tenn. (*see* Richland River) ..... I, 469; V, 3074
Big Sandy River, W. Va. and Ky.:
Bridge between Kenova, W. Va., and Catlettsburg, Ky ..... I, 697
Improvement of ..... I, 496; V, 3347
Improvement of Levisa Fork ..... I, 499; V, 3360
Improvement of Tug Fork ..... I, 498; V, 3357
Operating and care of lock and dam ..... I, 498; V, 3353
Survey of, including Levisa and Tug forks ..... I, 503; V, 3400
Big Stone Lake, Minn., survey of ..... I, 442; IV, 2833
Big Sunflower River, Miss., improvement of ..... I, 411; IV, 2537
Billingsport, N. J., removal of wreck in Delaware River below ..... I, 206; II, 1589
Bills of Congress authorizing construction of bridges ..... I, 40; VIII, 5103
Bird, Mary L. (schooner), removal of wreck of ..... I, 229; II, 1660
Biscayne Bay, Fla., examination, plan, and estimate for improvement ..... I, 316; III, 1986
Bismarck Harbor, N. Dak. (*see* Missouri River) ..... I, 444; IV, 2859
Black Lake, Mich., improvement of Holland Harbor ..... I, 557; V, 3891
Black River, Ark. and Mo.:
Improvement of ..... I, 421; IV, 2604
Removal of wreck near Elgin, Ark ..... I, 424; IV, 2613
Black River, La.:
Improvement of ..... I, 402; IV, 2503
Survey for locks and dams ..... I, 414; IV, 2544
Black River, Mich.:
Improvement at mouth ..... I, 579; VI, 3986
Improvement at Port Huron ..... I, 580; VI, 3987
Black River, N. C., improvement of ..... I, 273; III, 1813
Black River, Ohio, improvement of Lorain Harbor ..... I, 594; VI, 4054
Black Rock Harbor, Conn. (*see* Bridgeport) ..... I, 129; II, 1339
Black Rock Harbor, N. Y.:
Examination of Lake Erie entrance to ..... I, 611
Improvement of Buffalo entrance to ..... I, 608; VI, 4135
Black Warrior River, Ala.:
Examination for Locks and Dams Nos. 1, 2, and 3, below Tuscaloosa ..... I, 360
Improvement above Tuscaloosa ..... I, 346; III, 2167
Improvement below Tuscaloosa ..... I, 346; III, 2177
Operating and care of locks and dams ..... I, 346; III, 2171
Blackwater River, Fla. and Ala., improvement of ..... I, 338; III, 2126
Block Island, R. I.:
Construction of harbor of refuge ..... I, 108; II, 1272
Improvement of Great Salt Pond ..... I, 109; II, 1276
Blood River, La. (*see* Tickfaw) ..... I, 362; III, 2241
Boards:
Of Ordnance and Fortification ..... I, 6
On Fortifications and other Defenses (Endicott Board) ..... I, 5
On Torpedo System ..... I, 5, 731
The Board of Engineers ..... I, 5, 6, 727
Boats. *See* Dredge *and* Snag boats, Steamboats, *and* Wrecks.
Boca Grande, Fla., examination, plan, and estimate for improvement ..... I, 327; III, 2048, 2053

Bœuf River, La., improvement of ..... I, 405; IV, 2515
Bogue Chitto, La., improvement of ..... I, 358; III, 2222
Bogue Falia, La., improvement of ..... I, 361; III, 2240
Bogue Inlet and Sound, N. C. (*see* Beaufort-New River waterway) . I, 271; III, 1810
Boothbay Harbor, Me., examination and survey ..... I, 63; II, 1117, 1120
Boston Harbor, Mass.:
Bridge across Charles River to Cambridge (West Boston Bridge) .... I, 697
Bridge across Fort Point Channel (Broadway Bridge) ..... I, 701
Bridges across Mystic River to Chelsea ..... I, 698
Bridges across Mystic River to Malden ..... I, 700
Defenses of ..... I, 6, 12, 15, 773
Examination of ..... I, 94
Harbor lines at Cambridge ..... I, 40; II, 1225
Improvement of ..... I, 81; II, 1194
Bostrop (Bastrop) Bayou, Tex., examination and survey ..... I, 395; IV, 2414, 2416
Boulevards:
See also Roads.
Memorial bridge and, between Washington, D. C., and Mount Vernon, Va ..... I, 43, 704; VIII, 5125
Brandywine Shoal Light, Delaware Bay, removal of wreck near .... I, 206; II, 1588
Branford Harbor, Conn., examination of ..... I, 142
Brazos River, Tex.:
Examination and survey of mouth ..... I, 396; IV, 2426
Examination from mouth to Waco ..... I, 398
Improvement between Velasco and Richmond, including mouths of adjacent streams ..... I, 391, 392; IV, 2334, 2335
Improvement of mouth ..... I, 390; IV, 2332
Brazos Santiago Harbor, Tex.:
Examination off Point Isabel ..... I, 397; IV, 2469
Improvement of ..... I, 393; IV, 2340
Breach Inlet, Charleston Harbor, S. C., bridge between Sullivan and Long islands ..... I, 700
Breakwaters, public, occupancy of, by private parties ..... I, 40; VIII, 5085
Breton Bay, Md., examination and survey ..... I, 254; II, 1743, 1745
Brewerton, Ala., bridge across Conecuh River at Hendleys Ferry ..... I, 697
Bridge Creek Landing, Va., monument and wharf (*see* Public buildings and grounds) ..... I, 711; VIII, 5227, 5266
Bridgeport Harbor, Conn., improvement of ..... I, 129; II, 1339
Bridges across navigable waters:
Alteration of ..... I, 41, 701, 702
Aqueduct Bridge, Washington, D. C., repair of ..... I, 703; VIII, 5123
Construction of ..... I, 41, 697, 698
Examination of Congressional bills authorizing construction ..... I, 40
Examination of plans and locations ..... I, 41, 697, 698
Long Bridge, Washington, D. C., rebuilding of ..... I, 236; II, 1702
Memorial bridge, Washington, D. C ..... I, 43, 704; VIII, 5125
Obstructing navigation ..... I, 41, 701, 702
Report upon bill H. R. 1065, providing for bridges across certain waters ..... I, 40; VIII, 5103
Stone Bridge, Sakonnet River, R. I., alteration of ..... I, 100; II, 1251
Bridges in Yellowstone National Park, construction, etc., of .... I, 716; VIII, 5403
Bristol Bar, Patuxent River, Md., examination and survey ... I, 254; II, 1739, 1741
Broad Creek River, Del., improvement of ..... I, 225; II, 1653
Broadkill Creek, Del., improvement of ..... I, 216; II, 1641
Broad Sound, Boston Harbor, Mass.:
Examination of ..... I, 94
Improvement of ..... I, 81; II, 1194
Broadway Bridge, across Fort Point Channel, Boston, Mass ..... I, 701
Bronx River, N. Y., improvement of ..... I, 146; II, 1389
Brooklyn, Ill. (*see* Ohio River) ..... I, 469; V, 3085
Brooklyn, N. Y. *See* New York Harbor.
Browns Creek, N. Y., improvement of ..... I, 157; II, 1417
Brunswick, Ga.:
Examination and survey of inner harbor ..... I, 306; III, 1962, 1964
Improvement of inner harbor ..... I, 302; III, 1948
Survey of outer bar ..... I, 306
Bryan, W. J. (steamer), removal of wreck of ..... I, 424; IV, 2613
Bucksport Harbor, Penobscot River, Me., examination and survey . I, 63; II, 1103, 1107
Bucksport Narrows, Penobscot River, Me., examination at and near .. I, 63; II, 1101

Buffalo, N. Y.:
Examination of Lake Erie entrance to Erie Basin and Black Rock Harbor ... I; 611
Harbor lines ... I, 40; VI, 4156
Improvement of Buffalo entrance to Erie Basin and Black Rock Harbor ... I, 608; VI, 4135
Improvement of channels in waters connecting Great Lakes ... I, 569; VI, 3947
Improvement of harbor ... I, 606; VI, 4113
Buffalo Bayou, Tex., improvement of ... I, 386; IV, 2327, 2330
Buffalo Fork, Snake River, Wyo., road to Fort Washakie ... I, 731; VIII, 5453
Buffalo Fork, White River, Ark., improvement of ... I, 420; IV, 2601
Buildings and grounds, public, District of Columbia ... I, 710; VIII, 5227
Bulliards Cove, Bayou Teche, La., bridge at ... I, 698
Bundys, Oreg., bridge across Long Tom River ... I, 701
Burlington Bay, Minn., examination of ... I, 522
Burlington County, N. J., bridge of ... I, 701
Burlington Harbor, Vt., improvement of ... I, 168; II, 1482
Bush Bluff light-ship, Elizabeth River, Va., removal of wrecked cars below ... I, 264; II, 1784
Buttermilk Channel, New York Harbor, N. Y.:
Examination of ... I, 167
Improvement of ... I, 163; II, 1464
Byram River, N. Y. *See* Port Chester Harbor.

C.

Cables for submarine mines ... I, 12, 35, 37
Cache River, Ark.:
Bridge obstructing ... I, 703
Improvement of ... I, 421; IV, 2602
Cache River, Ill.:
Examination and survey for preventing Mississippi River from breaking into ... I, 431; IV, 2672, 2674
Prevention of Mississippi River from breaking into ... I, 429; IV, 2666
Caddo (Fairy) Lake, Tex. and La. (*see* Cypress Bayou) ... I, 401; IV, 2502
Cairo, Ill.:
Examination and survey for preventing break in Mississippi River near ... I, 431; IV, 2672, 2674
Prevention of break in Mississippi River near ... I, 429; IV, 2666
Calais, Me., repair of piers in St. Croix River below ... I, 44
Calcasieu Parish, La., bridge across Houston River ... I, 699
Calcasieu River, La., improvement of mouth and passes ... I, 375; III, 2266
California and Northern Railway Company, bridge of ... I, 701
California Débris Commission ... I, 696; VIII, 5007
California, hydraulic mining in ... I, 696; VIII, 5007
Caloosahatchee River, Fla.:
Examination and survey of Kissimmee River to the Gulf, via ... I, 327
Examination and survey of Orange River to the Gulf, via ... I, 326; III, 2032, 2035
Improvement of ... I, 316; III, 2015
Calumet Harbor and River, Ill. and Ind.:
Bridge across river at Ninety-fifth street ... I, 701
Bridge at South Chicago ... I, 699
Improvement of harbor ... I, 542; V, 3788
Improvement of river ... I, 544; V, 3792
Cambridge Harbor, Md., removal of wreck in ... I, 229; II, 1660
Cambridge Harbor, Mass.:
Harbor lines in Charles River ... I, 40; II, 1225
West Boston Bridge, across Charles River ... I, 697
Camden Harbor, Ark.:
Examination of ... I, 415
Improvement of Ouachita River ... I, 402; IV, 2503
Survey of Ouachita River for locks and dams ... I, 414; IV, 2544
Camden Harbor, Me., examination and survey ... I, 63; II, 1111, 1114
Camden Harbor, N. J.:
Defenses of Delaware River ... I, 6, 20, 35, 842
Improvement of Cooper Creek ... I, 199; II, 1580
Improvement of Delaware River ... I, 193; II, 1566
Canadian Canal, Sault Ste. Marie, Ontario, commerce through ... I, 571, 572; VI, 3960
Canals, etc. (*see also* Waterways) ... I, 40
Albemarle and Chesapeake Canal, N. C., waterway via ... I, 262; II, 1778
Allegheny River, Pa., locks and dams ... I, 483; V, 3257

Canals, etc.—Continued.
Appropriation for operation, care, and maintenance ..... I, 4
Barren River, Ky., locks and dams ..... I, 511; V, 351
Benton Harbor Canal, Mich (*see* St. Joseph Harbor) ..... I, 552; V, 387
Big Barren River, Ky., locks and dams ..... I, 511; V, 351
Big Sandy River, W. Va. and Ky., locks and dams I, 496, 498, 503; V, 3347, 3353, 340
Big Stone Lake, Minn., reservoir dam ..... I, 442; IV, 283
Black River, La., locks and dams ..... I, 414; IV, 254
Black Warrior River, Ala., locks and dams ..... I, 846, 860; III, 2167, 2171, 217
Canadian Canal, Sault Ste. Marie, Ontario ..... I, 571, 572; VI, 396
Cascades Canal, Columbia River, Oreg ..... I, 658, 661; VI, 4324, 432
Chicago Drainage Canal, Ill ..... I, 42
Clubfoot and Harlowe Canal, N. C., waterway via ..... I, 270; III, 180
Colorado River, Tex., for canal around great raft ..... I, 397; IV, 246
Columbia River, Oreg. and Wash., canal and locks between The Dalles Rapids and Celilo Falls ..... I, 66
Columbia River, Oreg. and Wash., Cascades Canal ..... I, 658, 661; VI, 4324, 432
Coosa River, Ga. and Ala., locks and dams ..... I, 341, 343; III, 2137, 2143, 214
Crooked Slough, Ill., dam across ..... I, 434; IV, 275
Cumberland River, Tenn. and Ky., locks and dams ..... I, 454; IV, 289
Davis Island Dam, Ohio River, Pa ..... I, 473; V, 314
Des Moines Rapids Canal and Dry Dock, Mississippi River ..... I, 433; IV, 274
Des Plaines and Illinois rivers to Lake Michigan ..... I, 549; V, 385
Dismal Swamp Canal, N. C., at South Mills, to and including Beaufort and Ocracoke inlets ..... I, 265, 27
Dismal Swamp Canal, Va. and N. C., improvement of waterway via ..... I, 261; II, 177
Duluth Canal, Minn ..... I, 514; V, 355
Erie Canal, N. Y., preservation of bench marks ..... I, 715; VIII, 540
Estherville-Minim Creek Canal, S. C. (*see also* Santee River) ..... I, 283, 291; III, 1856, 1894, 189
Fox River, Wis., locks and dams ..... I, 536, 537; V, 3712, 372
Galena River, Ill., lock and dam ..... I, 433; IV, 275
Galveston and Brazos Canal, Tex. (*see* Oyster Creek) ..... I, 396; IV, 2418, 242
Grand Rapids Lock and Dam, Wabash River ..... I, 507, 508; V, 3497, 349
Great Kanawha River, W. Va., locks and dams (*see* Kanawha) ..... I, 490, 492; V, 3322, 332
Green River, Ky., Lock No. 2, at Rumsey ..... I, 509; V, 350
Green River, Ky., Lock No. 5 ..... I, 510; V, 350
Green River, Ky., operating and care of locks and dams ..... I, 511; V, 351
Illinois and Des Plaines rivers to Lake Michigan ..... I, 549; V, 385
Illinois and Mississippi Canal, Ill ..... I, 546, 549, 550; V, 3810, 385
Illinois River, Ill., locks and dams ..... I, 545, 546; V, 3798, 380
Kampsville Lock and Dam, Illinois River, Ill ..... I, 545, 546; V, 3798, 380
Kanawha River, W. Va., locks and dams ..... I, 490, 492; V, 3322, 332
Kempeska Lake, S. Dak., reservoir dam ..... I, 45
Kentucky River, Ky., locks and dams ..... I, 500, 502; V, 3363, 336
Lagrange Lock and Dam, Illinois River, Ill ..... I, 545, 546; V, 3798, 380
Levisa Fork, Big Sandy River, Ky., locks and dams ..... I, 496, 499, 503; V, 3347, 3360, 340
Licking River, Ky., lock and dam ..... I, 476; V, 315
Little Kanawha River, W. Va., lock and dam ..... I, 489, 490; V, 3317, 331
Louisville and Portland Canal, Ky ..... I, 503, 506; V, 3463, 348
Michigan Lake to Illinois and Des Plaines rivers ..... I, 549; V, 385
Michigan Lake to Sturgeon Bay, Wis., examination of ..... I, 53
Michigan Lake to Sturgeon Bay, Wis., harbor of refuge ..... I, 526; V, 367
Michigan Lake to Sturgeon Bay, Wis., improvement of ..... I, 525; V, 365
Michigan Lake to Sturgeon Bay, Wis., operating and care ..... I, 526; V, 366
Minim Creek-Estherville Canal, S. C. (*see also* Santee River) ..... I, 283, 291; III, 1856, 1894, 189
Mississippi River, between St. Paul and Minneapolis, Minn., locks and dams ..... I, 434; IV, 276
Mississippi River, dam across Crooked Slough, Ill ..... I, 434; IV, 275
Mississippi River, Des Moines Rapids Canal and Dry Dock ..... I, 433; IV, 274
Mississippi River, reservoir dams ..... I, 435, 437, 443; IV, 2786, 280
Mississippi River to Lake Superior ..... I, 521; V, 361
Monongahela River locks and dams ..... I, 477, 478, 480; V, 3225, 3228, 323
Morgan Canal, Tex., improvement of waterway via ..... I, 386; IV, 2325, 232
Morgan Canal, Tex., operating and care ..... I, 388; IV, 232
Mosquito Creek Canal, S. C. (*see* Santee River) ..... I, 283; III, 185

Canals, etc.—Continued.
Muscle Shoals Canal, Tennessee River, Ala. I, 463; V, 2934
Muskingum River, Ohio, locks and dams. I, 487, 488; V, 3297, 3300
Ohio River, Davis Island Dam, Pa. I, 473; V, 3140
Ohio River, Louisville and Portland Canal, Ky. I, 503, 506; V, 3463, 3482
Ohio River, Marietta to the Big Miami, locks and dams. I, 476; V, 3201
Ohio River, movable dams. I, 473; V, 3146
Operation, care, and maintenance, appropriation for. 1, 40
Osage River, Mo., lock and dam (*see* Missouri River Commission). I, 695; VII, 4935, 4944, 4947
Otter Tail Lake, Minn., reservoir dam. I, 442; IV, 2830
Ouachita River, Ark. and La., locks and dams. I, 414; IV, 2544
Plaquemine Bayou, La., lock construction. I, 369; III, 2251
Ponsett Lake, S. Dak., reservoir dam. I, 451
Portage Lake and River, Houghton County, Mich., waterway via. I, 517, 518; V, 3598
Puget Sound to lakes Union and Washington. I, 684; VI, 4483
Red Lake, Minn., lock and dam. I, 441; IV, 2828
Red River, from Shreveport, La., to Denison, Tex., locks and dams. I, 415
Rock River, Ill., canal around. I, 546, 549, 550; V, 3810, 3853
Rough River, Ky., lock and dam. I, 511, 512; V, 3539, 3541
St. Clair Flats Canal, Mich. I, 582, 583, 587; VI, 3993, 3994
St. Marys Falls Canal, Mich. I, 570, 571; VI, 3952, 3956
Sioux River, S. Dak., reservoir dam. I, 451
Sturgeon Bay and Lake Michigan Canal, Wis., examination of. I, 539
Sturgeon Bay and Lake Michigan Canal, Wis., harbor of refuge. I, 526; V, 3672
Sturgeon Bay and Lake Michigan Canal, Wis., improvement of. I, 525; V, 3659
Sturgeon Bay and Lake Michigan Canal, Wis., operating and care. I, 526; V, 3666
Superior Lake to Mississippi River. I, 521; V, 3613
Tennessee River at Moccasin Bend. I, 468; V, 3005
Tennessee River at the "Suck," locks and dams. I, 468; V, 2956
Tennessee River below Chattanooga, Tenn., canals, etc. I, 460; V, 2912
Tennessee River, Muscle Shoals Canal, Ala. I, 463; V, 2934
Tombigbee River, Ala., locks and dams. I, 347, 360; III, 2202
Traverse Lake, Minn., reservoir dam. I, 442; IV, 2833
Tug Fork, Big Sandy River, W. Va. and Ky., locks and dams. I, 496, 498, 503; V, 3347, 3357, 3400
Union Lake, Wash., waterway via. I, 684; VI, 4483
Wabash River, Grand Rapids Lock and Dam. I, 507, 508; V, 3497, 3498
Warrior River, Ala., locks and dams. I, 346, 360; III, 2167, 2171, 2177
Washington Lake to Puget Sound, Wash. I, 684; VI, 4483
West Fork River, W. Va., locks and dams. I, 486; V, 3267
White River, Ark., upper, locks and dams. I, 419; IV, 2596
Willamette Falls Canal, Willamette River, Oreg. I, 675; VI, 4368, 4374
Yamhill River, Oreg., lock and dam. I, 667; VI, 4347
Youghiogheny River, Pa., locks and dams. I, 486; V, 3283
Canarsie Bay, N. Y., improvement of. I, 156; II, 1415
Caney Creek, Tex., examination and survey. I, 397; IV, 2453, 2455
Cape Ann, Mass.:
Construction of harbor of refuge in Sandy Bay. I, 72; II, 1161
Examination and survey of piers and breakwater at Rockport. I, 77; II, 1177, 1178
Resurvey and estimate of cost at breakwater, Sandy Bay, including project for completing harbor of refuge. I, 77; II, 1184
Cape Charles City, Va., improvement of harbor. I, 259; II, 1768
Cape Fear River, N. C.:
Defenses of Wilmington. I, 6, 11, 12, 23, 897
Examination at Wilmington and up to Fayetteville. I, 277
Improvement above Wilmington. I, 274; III, 1816
Improvement at and below Wilmington. I, 274; III, 1818
Improvement of Northeast Branch. I, 273; III, 1815
Cape Florida Entrance, Biscayne Bay, Fla., examination of. I, 316; III, 1986
Cape Hatteras, N. C., harbor of refuge (*see* Cape Lookout). I, 276; III, 1829
Cape Henry, Va., defenses of entrance to Chesapeake Bay at. I, 6
Cape Lookout, N. C., examination and survey for harbor of refuge. I, 276; III, 1829
Cape Nome Transportation, Bridge and Development Company, bridge of. I, 698
Cape Porpoise Harbor, Me., improvement of. I, 65; II, 1146
Cape Vincent Harbor, N. Y., improvement of. I, 616; VI, 4173
Capitol, the, Washington, D. C., telegraph line connecting Executive Departments with (*see* Public buildings and grounds). I, 710; VIII, 5227, 5262
Caravan (barge), removal of wreck of. I, 264; II, 1783

Carquinez (Karquines) Strait, Cal.:
Examination of channel to San Joaquin River ..... I, 634
Examination, plan, and estimate for improvement of channel to Golden Gate ..... I, 634; VI, 4258, 4260
Carrabelle Bar and Harbor, Fla.:
Examination of harbor ..... I, 344
Examination, plan, and estimate of cost for improvement of East Pass ..... I, 343; III, 2152, 2157
Improvement of ..... I, 328; III, 2088
Carriages, disappearing ..... I, 7
Carrie Furnaces, Pa., bridge across Monongahela River ..... I, 697
Carrollton Electric Railway and Bridge Company, bridge of ..... I, 699
Carrollton, Ky., bridge across Kentucky River ..... I, 699
Carters Creek, Va., examination and survey ..... I, 254; II, 1747, 1750
Caruthersville, Mo. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Carvers Harbor, Vinalhaven, Me., improvement of ..... I, 56; II, 1092
Cascades Canal, Columbia River, Oreg.:
Construction of ..... I, 658; VI, 4324
Operating and care ..... I, 661; VI, 4329
Casemates:
Armored ..... I, 7, 35
Mining ..... I, 12, 13, 35, 37
Castle Williams, Governors Island, N. Y., removal of wreck below ..... I, 166; II, 1473
Caswell, Fort, N. C., defenses at. *See* Wilmington.
Catlettsburg, Ky., bridge across Big Sandy River ..... I, 697
Cecil (schooner), removal of wreck of ..... I, 234; II, 1693
Centennial Lake, Miss. (*see* Yazoo River) ..... I, 408; IV, 2524
Champlain Lake, N. Y. and Vt.:
Bridge between Alburg, Vt., and Champlain, N. Y ..... I, 697
Burlington Harbor, Vt., improvement of ..... I, 168; II, 1482
Defenses of ..... I, 6, 30, 973
Narrows, improvement of ..... I, 170; II, 1485
North and South Hero islands, improvement of channel between ..... I, 167
Champlain, N. Y., bridge across Lake Champlain at ..... I, 697
Charles River, Boston, Mass.:
Examination below Charles River Bridge ..... I, 94
Harbor lines at Cambridge ..... I, 40; II, 1225
Improvement of ..... I, 81; II, 1194
West Boston Bridge, to Cambridge, construction of ..... I, 697
Charleston and Seashore Railroad Company, bridge of ..... I, 700
Charleston Consolidated Railway, Gas and Electric Company, bridge of ..... I, 700
Charleston Harbor, S. C.:
Bridge across Breach Inlet ..... I, 700
Defenses of ..... I, 6, 24, 911
Examination and survey to Alligator Creek or River ..... I, 292; III, 1908
Examination of Ashley River ..... I, 292
Improvement of ..... I, 287; III, 1867
Removal of sunken logs in waterway to Beaufort, S. C ..... I, 291; III, 1876
Charlestown Harbor, Boston, Mass.:
Examination at and below the navy-yard ..... I, 94
Improvement of (*see* Boston) ..... I, 81; II, 1194
Charlevoix Harbor, Mich., improvement of ..... I, 566; V, 3928
Charlotte Harbor, Fla.:
Examination and survey of inside passage to Puntarasa ..... I, 327; III, 2041, 2043
Examination, plan, and estimate for improvement, including Boca Grande ..... I, 327; III, 2048, 2053
Improvement of ..... I, 317; III, 2017
Charlotte Harbor, N. Y.:
Improvement of ..... I, 612; VI, 4163
Water levels ..... I, 715; VIII, 5402
Charts:
Military and other maps ..... I, 718, 721; VIII, 5445
Northern and Northwestern Lakes ..... I, 711; VIII, 5317
Chatham Harbor, Mass.:
Improvement of ..... I, 92; II, 1217
Removal of wreck in New Harbor ..... I, 93; II, 1218
Chattahoochee River, Ga. and Ala.:
Improvement below Columbus, Ga ..... I, 333; III, 2106
Improvement between Westpoint and Franklin, Ga ..... I, 334; III, 2110
Survey between Westpoint and Franklin, Ga ..... I, 344

Cheboygan Harbor, Mich.:
Examination and survey ..... I, 587; VI, 4012
Improvement of ..... I, 574; VI, 3973
Chefuncte River, La., improvement of ..... I, 361; III, 2240
Chehalis River, Wash., improvement of ..... I, 680; VI, 4476
Chelsea, Mass., bridges across Mystic River to Boston ..... I, 698
Chelsea Creek, Mass. (*see* Boston Harbor) ..... I, 81; II, 1194
Chequamegon Bay, Wis. (*see* Ashland Harbor) ..... I, 516; V, 3592
Chesapeake Bay, Md. and Va.:
Cape Charles City Harbor, Va., improvement of ..... I, 259; II, 1768
Defenses of entrance, at Cape Henry, Va ..... I, 6
Defenses of Hampton Roads, Va ..... I, 6, 11, 23, 886
Hampton Roads, Va., examination and survey at Middle Ground Bar ..... I, 265; II, 1785, 1788
Rockhall Harbor, Md., examination, plan, and estimate for improvement ..... I, 230; II, 1670
Rockhall Harbor, Md., improvement of ..... I, 218; II, 1643
Waterway from Norfolk, Va., to Albemarle Sound, N. C., via Currituck Sound ..... I, 262; II, 1778
Waterway from Norfolk, Va., to sounds of North Carolina, via Pasquotank River ..... I, 261; II, 1778
Wreck off Pooles Island, removal of ..... I, 234; II, 1693
Wrecks on Lower Middle Ground and Tail of the Horseshoe ..... I, 264; II, 1783
Chesconnessex Creek, Va., examination of ..... I, 265
Chester Creek, Pa., removal of wreck in ..... I, 206; II, 1589
Chester River, Md., improvement of ..... I, 219; II, 1645
Chicago and West Michigan Railway Company, bridge of ..... I, 702
Chicago Drainage Canal, Ill ..... I, 42
Chicago Harbor and River, Ill.:
Bridge across Calumet River at Ninety-fifth street ..... I, 701
Bridge across Calumet River at South Chicago ..... I, 699
Bridge across South Branch at Canal street ..... I, 701
Drainage canal ..... I, 42
Examination and survey ..... I, 550; V, 3863, 3865
Improvement of Calumet (South Chicago) Harbor ..... I, 542; V, 3788
Improvement of channels in waters connecting Great Lakes ..... I, 569; VI, 3947
Improvement of outer harbor ..... I, 540; V, 3779
Improvement of river ..... I, 541; V, 3784
Survey of Illinois and Des Plaines rivers for extension of navigation to Lake Michigan ..... I, 549; V, 3855
Chickasahay River, Miss., improvement of ..... I, 353; III, 2213
Chief of Engineers, officers on duty in office of the ..... I, 723
Chincoteague Bay, Va., improvement of waterway to Delaware Bay ..... I, 217; II, 1642
Chipola River, Fla.:
Improvement of lower river ..... I, 330; III, 2095
Improvement of upper river ..... I, 331; III, 2099
Chippewa River, Wis., improvement of ..... I, 437; IV, 2806
Chitto, Bogue, La., improvement of ..... I, 358; III, 2222
Chocolate Bayou, Tex., examination and survey ..... I, 395; IV, 2403, 2406
Choctaw, Oklahoma and Gulf Railroad Company, bridge of ..... I, 703
Choctawhatchee River, Fla. and Ala., improvement of ..... I, 335; III, 2112
Choptank River, Md.:
Improvement of ..... I, 220; II, 1646
Removal of wreck in Cambridge Harbor ..... I, 229; II, 1660
Christiana River, Del. (*see* Wilmington Harbor) ..... I, 208; II, 1626
City of Duluth (steamer), removal of wreck of ..... I, 568; V, 3933
City of Waco (steamship), removal of wreck of ..... I, 394; IV, 2341
Civilian assistants to certain engineer officers ..... I, 35
Claiborne Harbor, Md., examination and survey ..... I, 230; II, 1677, 1680
Clara (schooner), removal of wreck of ..... I, 206; II, 1589
Clark Fork, Columbia River, Wash. (*see* Pend Oreille River) ..... I, 690; VI, 4494
Clatskanie River, Oreg., improvement of ..... I, 672; VI, 4363
Clear Creek, Tex., examination and survey ..... I, 395; IV, 2385, 2388
Clearwater River, Idaho:
Bridge at mouth of Lapwai Creek ..... I, 700
Bridge near Kamiah ..... I, 699
Improvement of ..... I, 664; VI, 4337
Clearwater Short Line Railway Company, bridge of ..... I, 699

Clearwater Valley Railroad Company, bridge of ..... I, 700
Cleveland Harbor, Ohio:
Examination of ..... I, 604
Improvement of ..... I, 595; VI, 4063
Removal of wreck in Lake Erie near ..... I, 603; VI, 4096
Water levels ..... I, 715; VIII, 5402
Cleveland, H. G. (schooner), removal of wreck of ..... I, 603; VI, 4096
Clinch River, Tenn.:
Improvement of ..... I, 465; V, 2948
Survey of ..... I, 469; V, 3065
Clinton River, Mich., improvement of ..... I, 583; VI, 3996
Clubfoot and Harlowe Canal, N. C., improvement of waterway via ..... I, 270; III, 1806
Clubfoot Creek or River, N. C., improvement of waterway via ..... I, 270; III, 1806
Coanjock Bay, N. C., improvement of waterway via ..... I, 262; II, 1778
Coast defenses. *See* Fortifications.
Cocheco River, N. H., improvement of ..... I, 66; II, 1147
Coenties Reef, East River, N. Y.:
Examination and survey ..... I, 160; II, 1435, 1439
Improvement of ..... I, 152; II, 1403
Cohasset Harbor, Mass., examination and survey ..... I, 93; II, 1221, 1222
Colorado, department of the, reconnaissances and explorations ..... I, 718; VIII, 5451
Colorado River, Nev., examination between El Dorado Canyon and Rioville ..... I, 624
Colorado River, Tex.:
Examination for canal around great raft ..... I, 397; IV, 2461
Examination up to foot of great raft ..... I, 397; IV, 2458
Columbia (bugeye), removal of wreck of ..... I, 229; II, 1661
Columbia, department of the, reconnaissances and explorations ..... I, 718; VIII, 5450
Columbia, District of. *See* Washington.
Columbia River, Oreg. and Wash.:
Cascades Canal, construction of ..... I, 658; VI, 4324
Cascades Canal, operating and care ..... I, 661; VI, 4329
Celilo, Oreg., improvement above ..... I, 652; VI, 4319
Celilo Falls to The Dalles Rapids, examination for canal and locks ..... I, 666
Celilo Falls to The Dalles Rapids, boat railway ..... I, 655; VI, 4322
Clark Fork (*see* Pend Oreille River) ..... I, 690; VI, 4494
Gauging ..... I, 675; VI, 4368
Mouth of, defenses at ..... I, 6, 33, 1018
Mouth of, examination and survey ..... I, 676; VI, 4430, 4434
Mouth of, improvement at ..... I, 671; VI, 4361
Mouth to Willamette River, examination and survey ..... I, 676; VI, 4416, 4418
Mouth to Willamette River, improvement from ..... I, 669; VI, 4352
Three-mile Rapids, improvement at ..... I, 655; VI, 4322
Tongue Point, Oreg., improvement below ..... I, 670; VI, 4360
Vancouver, Wash., to Willamette River, improvement from ..... I, 661; VI, 4334
Commercial statistics of canals at Sault Ste. Marie, Mich., and Ontario ..... I, 571, 572; VI, 3959
Compton Creek, N. J., improvement of ..... I, 184; II, 1512
Conecuh River, Ala.:
Bridges at Hendleys Ferry, near Brewerton, and at Parkers Ferry ..... I, 697
Improvement of ..... I, 339; III, 2129
Congaree River, S. C.:
Improvement between Columbia and Granby ..... I, 286; III, 1864
Improvement of ..... I, 285; III, 1863
Congress:
See also Laws.
Examination of bills of, authorizing construction of bridges ..... I, 40
Report upon bill H. R. 1065, providing for bridges across certain waters ..... I, 40; VIII, 5103
Conneaut Harbor, Ohio, improvement of ..... I, 601; VI, 4091
Connecticut, defenses of coast of ..... I, 6, 10, 11, 17, 814
Connecticut River, Conn., improvement below Hartford ..... I, 119; II, 1328
Contentnia Creek, N. C., improvement of ..... I, 268; III, 1801
Contingencies of rivers and harbors, estimate of appropriation for ..... I, 693
Continuing contracts ..... I, 39
Allegheny River, Pa., locks and dams ..... I, 483; V, 3257
Ambrose Channel, New York Harbor, N. Y ..... I, 161; II, 1459
Ashtabula Harbor, Ohio ..... I, 600; VI, 4075
Baltimore Harbor, Md ..... I, 231; II, 1687

Continuing contracts—Continued.
Bay Ridge Channel, New York Harbor, N. Y ..... I, 163; II, 1464
Big Sandy River, Ky. and W. Va ..... I, 496; V, 3847
Black River (Lorain) Harbor, Ohio ..... I, 594; VI, 4054
Black Rock Harbor, Buffalo, N. Y ..... I, 608; VI, 4135
Black Warrior River, Ala., below Tuscaloosa ..... I, 346; III, 2177
Black Warrior River, Ala., from Tuscaloosa to Daniels Creek ..... I, 346; III, 2167
Boston Harbor, Mass ..... I, 81; II, 1194
Bridgeport Harbor, Conn ..... I, 129; II, 1339
Buffalo entrance to Erie Basin and Black Rock Harbor, N. Y ..... I, 608; VI, 4135
Buffalo Harbor, N. Y ..... I, 606; VI, 4113
Buttermilk Channel, New York Harbor, N. Y ..... I, 163; II, 1464
Calumet Harbor, Ill ..... I, 542; V, 3788
Cape Porpoise Harbor, Me ..... I, 65; II, 1146
Cascades Canal, Columbia River, Oreg ..... I, 658; VI, 4324
Charleston Harbor, S. C ..... I, 287; III, 1867
Chicago River, Ill ..... I, 541; V, 3784
Christiana River, Del ..... I, 208; II, 1626
Cleveland Harbor, Ohio ..... I, 595; VI, 4063
Columbia River at the Cascades, Oreg ..... I, 658; VI, 4324
Congaree River, S. C ..... I, 285; III, 1864
Croatan Sound, N. C., waterway via ..... I, 261; II, 1773
Cumberland River above Nashville, Tenn ..... I, 456; IV, 2896
Cumberland Sound, Ga. and Fla ..... I, 304; III, 1956
Deep Creek, Va., and waters connecting with Pamlico Sound ..... I, 261; II, 1773
Delaware Bay, Del., harbor of refuge ..... I, 197; II, 1576
Delaware River, N. J., Pa., and Del ..... I, 189; II, 1557
Detroit River, Mich ..... I, 584; VI, 3997
Duluth and Superior Harbor, Minn. and Wis ..... I, 514; V, 3554
East (Ambrose) Channel, New York Harbor, N. Y ..... I, 161; II, 1459
Elizabeth River, Va., to Pamlico Sound, N. C., waterway ..... I, 261; II, 1773
Erie Basin, Buffalo, N. Y ..... I, 608; VI, 4135
Everett Harbor, Wash ..... I, 686; VI, 4485
Falls of Ohio River at Louisville, Ky ..... I, 503; V, 3463
Galveston Harbor, Tex ..... I, 384; IV, 2308
Gowanus Bay channels, New York Harbor, N. Y ..... I, 163; II, 1464
Grays Harbor, Wash ..... I, 678; VI, 4468
Great Lakes, channels in connecting waters of ..... I, 569; VI, 3947
Gulfport, Miss., channel to Ship Island Harbor ..... I, 355; III, 2216
Hay Lake Channel, St. Marys River, Mich ..... I, 573; VI, 3969
Horn Island Harbor, Miss ..... I, 352; III, 2211
Hudson River, N. Y ..... I, 171; II, 1487
Humboldt Harbor and Bay, Cal ..... I, 632; VI, 4237
Illinois and Mississippi Canal, Ill ..... I, 546; V, 3810
Indiana Chute, Falls of Ohio River, Louisville, Ky ..... I, 503; V, 3463
Kenosha Harbor, Wis ..... I, 534; V, 3706
Kentucky River, Ky ..... I, 500; V, 3363
Keweenaw Bay to Lake Superior, Mich., waterway ..... I, 517; V, 3598
Lorain Harbor, Ohio ..... I, 594; VI, 4054
Michigan City outer harbor, Ind ..... I, 551; V, 3875
Milwaukee Bay, Wis., harbor of refuge ..... I, 531; V, 3695
Mississippi River, improving outlet at Pass a Loutre ..... I, 365; III, 2246
Mississippi River, Head of Passes to Ohio River ..... I, 694; VII, 4525
Mississippi River, between Missouri and Ohio rivers ..... I, 426; IV, 2631
Mississippi River, between Missouri River and St. Paul ..... I, 432; IV, 2692
Mississippi River, between St. Paul and Minneapolis ..... I, 434; IV, 2768
Missouri River, below Sioux City, Iowa ..... I, 695; VII, 4935
Mobile Harbor, Ala ..... I, 344; III, 2161
Monongahela River, W. Va. and Pa ..... I, 477, 478; V, 3225, 3228
Narragansett Bay, R. I ..... I, 102; II, 1257
New Haven Harbor, Conn ..... I, 123; II, 1333
New York Harbor, N. Y., Ambrose Channel ..... I, 161; II, 1459
New York Harbor, N. Y., Gowanus Bay channels ..... I, 163; II, 1464
Norfolk Harbor, Va., to Pamlico Sound, N. C., waterway ..... I, 261; II, 1773
Northern and Northwestern Lakes, channels connecting ..... I, 569; VI, 3947
Oakland Harbor, Cal ..... I, 626; VI, 4218
Ocmulgee River, Ga ..... I, 301; III, 1944
Ohio River, Falls of, at Louisville, Ky ..... I, 503; V, 3463
Ohio River, movable dams ..... I, 473; V, 3146
Osage River, Mo ..... I, 695; VII, 4935, 4944, 4947

Continuing contracts—Continued.
Pamlico Sound, N. C., waterway to Norfolk Harbor, Va. ... I, 261; II, 1773
Pascagoula River, Miss. ... I, 352; III, 2211
Pass a Loutre, Mississippi River ... I, 365; III, 2246
Patapsco River, Md ... I, 231; II, 1687
Philadelphia Harbor, Pa. ... I, 193; II, 1566
Plaquemine Bayou, La ... I, 369; III, 2251
Portage Lake harbor of refuge, Mich ... I, 564; V, 3902
Portland Harbor, Me., including Back Cove ... I, 60; II, 1067
Potomac River, below Washington, D. C ... I, 238; II, 1706
Providence River and Narragansett Bay, R. I. ... I, 102; II, 1257
Racine Harbor, Wis ... I, 533; V, 3702
Red Hook Channel, New York Harbor, N. Y. ... I, 163; II, 1464
Rockland Harbor, Me ... I, 54; II, 1069
Sabine Pass, Tex ... I, 380; III, 2276
Sacramento River, Cal ... I, 629; VI, 4250
St. Joseph Harbor, Mich ... I, 552; V, 3879
St. Marys River, Mich., Hay Lake Channel ... I, 573; VI, 3969
Sandbeach harbor of refuge, Mich ... I, 578; VI, 3983
San Francisco Harbor, Cal ... I, 625; VI, 4215
San Pedro Bay, Cal ... I, 621; VI, 4187
Savannah Harbor, Ga ... I, 292; III, 1913
Savannah River, Ga., between Augusta and Savannah ... I, 294; III, 1928
Sheboygan Harbor, Wis ... I, 530; V, 3687
Ship channel connecting waters of the Great Lakes ... I, 569; VI, 3947
Ship Island Harbor, Miss., channel to Gulfport ... I, 355; III, 2216
South Chicago Harbor, Ill. (*see* Calumet Harbor) ... I, 542; V, 3788
Superior Harbor, Wis ... I, 514; V, 3554
Superior Lake to Keweenaw Bay, Mich., waterway ... I, 517; V, 3598
Tampa Bay, Fla ... I, 321; III, 2022
Toledo Harbor, Ohio ... I, 589; VI, 4022
Tombigbee and Warrior rivers, below Tuscaloosa, Ala. ... I, 346; III, 2177
Union River, Me ... I, 49; II, 1081
Vicksburg Harbor, Miss ... I, 408; IV, 2524
Warrior River, Ala., below Tuscaloosa ... I, 346; III, 2177
Warrior River, Ala., from Tuscaloosa to Daniels Creek ... I, 346; III, 2167
White River (upper), Ark ... I, 419; IV, 2596
Willamette River, above Portland, Oreg ... I, 667; VI, 4347
Wilmington Harbor, Del ... I, 208; II, 1626
Winyah Bay, S. C. ... I, 281; III, 1851
Yamhill River, Oreg ... I, 667; VI, 4347
Yaquina Bay, Oreg ... I, 646; VI, 4291
Yazoo River, Miss., at the mouth ... I, 408; IV, 2524
Contracts, continuing. *See* Continuing contracts.
Cooper Creek, N. J., improvement of ... I, 199; II, 1580
Coosa River, Ga., and Ala.:
Improvement above East Tenn., Va. and Ga. R. R. Bridge ... I, 341; III, 2137
Improvement below East Tenn., Va. and Ga. R. R. Bridge ... I, 342; III, 2143
Operating and care of locks and dams ... I, 343; III, 2145
Coos Bay, Harbor, and River, Oreg.:
Dredging harbor ... I, 642; VI, 4280
Improvement of entrance to bay and harbor ... I, 640; VI, 4274
Improvement of river ... I, 644; VI, 4283
Copper Harbor, Mich., examination, plan, and estimate for improvement ... I, 522; V, 3636, 3641
Coquille River, Oreg.:
Improvement below Coquille ... I, 636; VI, 4266
Improvement between Coquille and Myrtle Point ... I, 638; VI, 4271
Core Sound, N. C., examination of waterway from South Mills to and including Beaufort and Ocracoke inlets ... I, 265, 277
Corporations, occupancy of public structures by ... I, 40; VIII, 5085
Corps of Engineers:
Changes in personnel ... I, 3
Laws of Fifty-sixth Congress, first session, affecting the ... VIII, 5459
Number and distribution of officers ... I, 3, 4
Officers detached ... I, 4
Officers on duty in office of the Chief of Engineers ... I, 723
Coscob Harbor, Conn., improvement of ... I, 188; II, 1349
Cottage City, Mass., examination at ... I, 111; II, 1293
Cotuit Harbor, Mass., examination of ... I, 111; II, 1287

Courtableau Bayou, La., improvement of ..... I, 371; III, 2259
Cowlitz River, Wash., improvement of ..... I, 674; VI, 4366
Crescent Bay and City, Cal., examination of harbor ..... I, 634; VI, 4262
Croatan Sound, N. C.:
Examination of waterway from South Mills to and including Beaufort and Ocracoke inlets ..... I, 265, 277
Improvement of waterway to Norfolk, Va., via Pasquotank River. I, 261; II, 1773
Crockett, David (barge), removal of wreck of ..... I, 166; II, 1472
Crooked River, Fla. *See* Carrabelle Bar and Harbor *and* Ocklockonnee River.
Crooked Slough, Ill., examination for dam across ..... I, 434; IV, 2759
Crystal River, Fla., examination and survey ..... I, 327; III, 2074, 2078
Cumberland River, Tenn. and Ky.:
Bridges across, report on Congressional bill providing for construction of ..... I, 40; VIII, 5103
Gauging (*see* Mississippi River) ..... I, 412; IV, 2540
Improvement above Nashville, Tenn ..... I, 456; IV, 2896
Improvement below Nashville, Tenn ..... I, 454; IV, 2891
Cumberland Sound, Ga. and Fla.:
Defenses of ..... I, 25, 917
Improvement of ..... I, 304; III, 1956
Cummings, William (canal boat), removal of wreck of ..... I, 206; II, 1588
Current River, Ark. and Mo.:
Examination between Crooked and Current creeks, Mo ..... I, 424; IV, 2614
Improvement of ..... I, 422; IV, 2608
Currituck Sound, N. C., improvement of waterway via ..... I, 262; II, 1778
Curtis Bay, Baltimore, Md.:
Harbor lines ..... I, 40; II, 1697
Improvement of channel to ..... I, 233; II, 1692
Cut-off, Apalachicola River, Fla., improvement of ..... I, 330; III, 2095
Cuyahoga River, Ohio. *See* Cleveland Harbor.
Cypher (lighter), removal of wreck of ..... I, 306; III, 1961
Cypress Bayou, Tex. and La., improvement of ..... I, 401; IV, 2502

D.

Daisy (canal boat), removal of wreck of ..... I, 166; II, 1473
Dams. *See* Canals *and* Waterways.
Darien Harbor, Ga., improvement of ..... I, 297; III, 1935
Davis Island Dam, Ohio River, Pa., operating and care ..... I, 473; V, 3140
Deals Island, Md., removal of wreck at ..... I, 229; II, 1661
Débris, mining, in California ..... I, 696; VIII, 5007
Deep Creek Branch, Elizabeth River, Va., improvement of waterway via ..... I, 261; II, 1773
Deep River, Wash., bridge across ..... I, 699
Defenses, seacoast. *See* Fortifications.
Delanco, N. J., bridge across Rancocas Creek or River ..... I, 701
Delaware Bay and River, N. J., Pa., and Del.:
Defenses of ..... I, 6, 20, 35, 842
Delaware Breakwater, construction of ..... I, 196; II, 1575
Harbor of refuge in bay, construction of ..... I, 197; II, 1576
Ice harbor at Marcushook, Pa., improvement of ..... I, 195; II, 1574
Improvement of river ..... I, 189; II, 1557
Philadelphia and Camden Harbor, improvement of ..... I, 193; II, 1566
Pier near Lewes, Del., construction of ..... I, 196; II, 1574
Plan and estimate for improvement below Christian street, Philadelphia ..... I, 207; II, 1615
Waterway to Chincoteague Bay, Va., improvement of ..... I, 217; II, 1642
Wrecks, removal of ..... I, 206; II, 1587
Delaware Breakwater, Del., construction of ..... I, 196; II, 1575
Delaware, Fort, Del., defenses at. *See* Delaware River.
Delta Point, Mississippi River, La. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Dennis Creek, N. J., removal of wreck in ..... I, 206; II, 1589
Departments, Executive, Washington, D. C., telegraph line connecting (*see* Public buildings and grounds) ..... I, 710; VIII, 5227, 5262
Departments, military, reconnaissances and explorations in ..... I, 718; VIII, 5445
Depot, Engineer, Willets Point, N. Y ..... I, 37, 1052
Derelicts. *See* Wrecks.
Deschutes River, Wash. (*see* Olympia Harbor) ..... I, 683; VI, 4481

Des Moines Rapids Canal and Dry Dock, Mississippi River, operating and care ..... I, 433; IV, 2744
Des Plaines River, Ill., survey for extension of navigation to Lake Michigan ..... I, 549; V, 3855
Deterioration of river and harbor works ..... I, 40; VIII, 5071
Detroit River, Mich.:
Examination of channel west of Grosse Isle ..... I, 587
Improvement of ..... I, 584; VI, 3997
Improvement of channels in waters connecting Great Lakes ..... I, 569; VI, 3947
Survey from Detroit to Lake Erie ..... I, 587; VI, 4015
Diamond Reef, East River, N. Y.:
Examination and survey ..... I, 160; II, 1435, 1439
Improvement of ..... I, 152; II, 1403
Dickinson Bayou, Tex., examination and survey ..... I, 395; IV, 2396, 2399
Disappearing carriages ..... I, 7
Dismal Swamp Canal, Va. and N. C.:
Examination of waterway from South Mills, N. C., to and including Beaufort and Ocracoke inlets ..... I, 265, 277
Improvement of waterway via ..... I, 261; II, 1773
District of Columbia. *See* Washington.
Dividing Creek, Md. (*see* La Trappe River) ..... I, 222; II, 1648
Divisions, engineer ..... I, 44
Divisions, military, reconnaissances and explorations in ..... I, 718; VIII, 5445
Doboy Bar, Ga., improvement of ..... I, 297; III, 1933
Dodson, Frank (canal boat), removal of wreck of ..... I, 206; II, 1589
Doe, Nellie (schooner), removal of wreck of ..... I, 110; II, 1281
Dog Island, St. Georges Sound, Fla., harbor lines ..... I, 40; III, 2158
Double Bayou, Tex., improvement of, including mouths of adjacent streams ..... I, 391; IV, 2334
Drayton, N. Dak., bridge across Red River of the North ..... I, 697
Dredge boats:
For Mississippi River and other waters ..... I, 41, 366; III, 2246
For works in Florida, construction of ..... I, 315; III, 1985
For works on Texas coast, procurement of ..... I, 391; IV, 2334
Sale of, when not needed ..... I, 44
Duck Creek (Smyrna River), Del.:
Examination of ..... I, 231
Improvement of ..... I, 212; II, 1635
Duck Island Harbor, Conn., construction of harbor of refuge ..... I, 122; II, 1331
Duluth Canal, Minn. (*see* Duluth Harbor) ..... I, 514; V, 3554
Duluth Harbor, Minn.:
Harbor lines ..... I, 40; V, 3642
Improvement of ..... I, 514; V, 3554
Improvement of channels in waters connecting Great Lakes ..... I, 569; VI, 3947
Dunkirk Harbor, N. Y.:
Examination and survey ..... I, 611; VI, 4148, 4150
Improvement of ..... I, 605; VI, 4108
Duwamish River, Wash.:
Bridge across ..... I, 700
Improvement of (*see* Puget Sound) ..... I, 681; VI, 4477
Duxbury Harbor, Mass., improvement of ..... I, 89; II, 1209
Dynamite batteries ..... I, 10, 35

E.

Eads, James B., improvement of South Pass, Mississippi River, by representatives of ..... I, 41, 360; III, 2225
East (Ambrose) Channel, New York Harbor, N. Y., improvement of ..... I, 161; II, 1459
East Bay Bayou, Tex., examination and survey ..... I, 394; IV, 2379, 2381
East Channel, New York Harbor, N. Y., improvement of ..... I, 161; II, 1459
East Chester Creek, N. Y., improvement of ..... I, 145; II, 1387
Eastern Bay, Md., examination and survey of Claiborne Harbor ..... I, 230; II, 1677, 1680
Eastern Branch, Elizabeth River, Va. (*see* Norfolk Harbor) ..... I, 255; II, 1763
East Pass, Carrabelle Harbor, Fla., examination, plan, and estimate for improvement ..... I, 343; III, 2152, 2157
East River, Ga. *See* Brunswick Harbor.
East River, N. Y.:
Bridge No. 3, at New York City ..... I, 700
Examination and survey of Diamond and Coenties reefs ..... I, 160; II, 1435, 1439
Harbor lines ..... I, 40; II, 1455, 1457

East River, N. Y.—Continued.
Improvement of ... I, 152; II, 1403
Improvement of Wallabout Channel ... I, 156; II, 1413
Wreck in, removal of ... II, 1422
Echo Bay, New Rochelle, N. Y., examination, plan, and estimate for improvement ... I, 160; II, 1423, 1429
Ecorse Township, Mich.:
Bridge of, across Rouge River at Dix avenue ... I, 702
Bridge of, across Rouge River at Fort street ... I, 700
Edenton Bay, N. C., improvement of ... I, 263; II, 1780
Elgin, Ark, removal of wreck in Black River ... I, 424; IV, 2613
Elizabeth River, N. J., improvement of ... I, 179; II, 1503
Elizabeth River, Va.:
Examination at vicinity of pier of Southern Railway Company, Norfolk ... I, 265
Harbor lines at Norfolk ... I, 40; II, 1791
Improvement of Norfolk Harbor and its approaches ... I, 255; II, 1763
Improvement of waterway to Albemarle Sound, N. C., via Currituck Sound ... I, 262; II, 1778
Improvement of waterway to sounds of North Carolina, via Pasquotank River ... I, 261; II, 1773
Improvement of Western Branch ... I, 256; II, 1765
Removal of wrecked cars from Sewall Point Channel ... I, 264; II, 1784
Removal of wreck in Southern Branch ... I, 264; II, 1783
Elkpoint, S. Dak. (*see* Missouri River) ... I, 444; IV, 2859
Elk River, Md., examination and survey ... I, 230; II, 1665, 1668
Elk River, Tenn. and Ala.:
Improvement of ... I, 467; V, 2952
Survey of ... I, 469; V, 3077
Elk River, W. Va.:
Examination up to Sutton ... I, 503; V, 3392
Improvement of ... I, 493; V, 3337
Ellen Maria (schooner), removal of wreck of ... I, 77; II, 1169
Elliott, John W. (sloop), removal of wreck of ... I, 206; II, 1588
Embankments ... I, 11, 35
Employees, injured, recommendation regarding aid to ... I, 44
Endicott Board, the ... I, 5
Engineer Depot, Willets Point, N. Y ... I, 37, 1052
Engineer divisions ... I, 44
Engineer officers, civilian assistants to certain ... I, 35
Engineers, Battalion of ... I, 36, 1050
Engineers, Chief of, officers on duty in office of the ... I, 723
Engineer School, Fort Totten, N. Y ... I, 36, 38, 1047
Engineers, Corps of:
Changes in personnel ... I, 3
Laws of Fifty-sixth Congress, first session, affecting the ... VIII, 5459
Number and distribution of officers ... I, 3, 4
Officers detached ... I, 4
Officers on duty in office of the Chief of Engineers ... I, 723
Engineers, The Board of ... I, 5, 6, 727
Engineer troops, equipment of ... I, 35, 38
Equipment of engineer troops ... I, 35, 38
Erie Basin, Buffalo, N. Y.:
Examination of Lake Erie entrance to ... I, 611
Improvement of Buffalo entrance to ... I, 608; VI, 4135
Erie Canal, N. Y., preservation of bench marks along ... I, 715; VIII, 5402
Erie Harbor, Pa.:
Improvement of ... I, 604; VI, 4099
Water levels ... I, 715; VIII, 5402
Erie Lake:
See also Northern and Northwestern Lakes.
Breakwater construction at harbors on ... VI, 4084
Removal of wrecks ... I, 603; VI, 4094, 4095, 4096
Water levels ... I, 715; VIII, 5319, 5402
Escambia County, Ala., bridges of ... I, 697
Escambia River, Fla., improvement of ... I, 339; III, 2129
Escanaba, Mich., water levels ... I, 715; VIII, 5402
Esopus Creek, N. Y. *See* Saugerties Harbor.
Essex River, Mass., improvement of ... I, 72; II, 1159

Estherville-Minim Creek Canal, S. C.:
Examination, plans, and estimates for extension of, to Alligator Creek or River ..... I, 291; III, 1894, 1897
Improvement of (*see* Santee River) ..... I, 283; III, 1856
Estimates of appropriations required:
Fortifications ..... I, 35
River and harbor examinations, surveys, etc ..... I, 686
River and harbor improvements ..... I, 39
Eureka Slough, Cal., bridge across ..... I, 701
Evansville, Ind. (*see* Ohio River) ..... I, 469; V, 3085
Everett Harbor, Wash., improvement of ..... I, 686; VI, 4487
Examinations, estimate of appropriation for ..... I, 686
Executive Departments, Washington, D. C., telegraph line connecting (*see* Public buildings and grounds) ..... I, 710; VIII, 5227, 5262
Executive Mansion, Washington, D. C. (*see* Public buildings and grounds) ..... I, 710; VIII, 5227
Exeter River, N. H., improvement of ..... I, 67; II, 1149
Explorations and reconnaissances in military divisions and departments ..... I, 718; VIII, 5445

F.

Fairbanks, R. G. (canal boat), removal of wreck of ..... I, 187; II, 1516
Fairhaven Harbor, Mass. *See* New Bedford.
Fairport Harbor, Ohio, improvement of ..... I, 598; VI, 4070
Fairy Lake, Tex. and La. (*see* Cypress Bayou) ..... I, 401; IV, 2562
Falia, Bogue, La., improvement of ..... I, 361; III, 2240
Fall River Harbor, Mass.:
Harbor lines in Mount Hope Bay ..... I, 40; II, 1311
Improvement of ..... I, 104; II, 1263
Falls of Ohio River, Louisville, Ky.:
Improvement of, including Indiana Chute ..... I, 503; V, 3462
Operating and care of Louisville and Portland Canal ..... I, 506; V, 3482
Farrell (tugboat), removal of wreck of ..... I, 167; II, 1475
Fayetteville, N. C., examination of Cape Fear River from Wilmington to ..... I, 277
Feather River, Cal.:
Improvement of ..... I, 628; VI, 4227
Improvement of, by California Débris Commission ..... I, 696; VIII, 5007
Fernandina, Fla., improvement of waterway to Savannah, Ga ..... I, 303; III, 1973
Filtration plant, Washington Aqueduct, D. C ..... I, 709; VIII, 5224
Finegan Slough, San Joaquin River, Cal., examination for closure of ..... I, 634
Fire Island Inlet, N. Y., examinations of ..... I, 160, 161; II, 1443
Fishers Island, N. Y., defenses at. *See* Long Island Sound.
Fishing Creek, N. C.:
Bridge across ..... I, 697
Improvement of ..... I, 266; III, 1796
Five-mile River Harbor, Conn., improvement of ..... I, 135; II, 1346
Flag Lake and River, Wis. (*see* Portwing Harbor) ..... I, 521; V, 3630, 3633
Flathead River, Mont., improvement of ..... I, 692; VI, 4501
Fleming Park, Pa., bridge across Ohio River ..... I, 701
Flint River, Ga., improvement of ..... I, 332; III, 2101
Florida:
Construction of dredge and snag boat ..... I, 315; III, 1985
Defenses of east coast ..... I, 6, 25, 923
Removal of water hyacinth ..... I, 315; III, 1985
Floyd, Sergt. Charles, monument to ..... I, 722; VIII, 5455
Flushing Bay, N. Y., improvement of ..... I, 151; II, 1401
Flynns Knoll, New York Harbor, N. Y., removal of wreck ..... I, 166; II, 1472
Forked Deer River, Tenn., improvement of ..... I, 453; IV, 2889
Fort Benton, Mont. (*see* Missouri River) ..... I, 444; IV, 2859
Fort Caswell, N. C., defenses at. *See* Wilmington.
Fort Delaware, Del., defenses at. *See* Delaware River.
Fortifications:
Board of Ordnance and Fortification ..... I, 6
Board on Fortifications and other Defenses (Endicott Board) ..... I, 5
Board on Torpedo System ..... I, 5, 731
Dynamite batteries ..... I, 10, 35
Employees, injured, recommendation regarding aid to ..... I, 44
Engineer divisions ..... I, 44
Estimates of appropriations required ..... I, 35

Fortifications—Continued.
General statement and progress of work ..... I, 5
Gun and mortar batteries ..... I, 6, 7, 35
Insular possessions ..... I, 6, 10, 35
Preservation and repair of ..... I, 11, 35, 38
Projects ..... I, 6
Range and position finders ..... I, 10, 35
Sea walls and embankments ..... I, 11, 35
Sites ..... I, 12, 35
Submarine mines ..... I, 12, 35, 37
Supplies for seacoast defenses ..... I, 11, 35, 37
The Board of Engineers ..... I, 5, 6, 727
Fort Monroe, Va., defenses at. *See* Hampton Roads.
Fort Morgan, Ala., examination of bar below, in Mobile Harbor ..... I, 360
Fort Pierre, S. Dak. (*see* Missouri River) ..... I, 444; IV, 2859
Fort Point Channel, Boston Harbor, Mass.:
Broadway Bridge, across ..... I, 701
Improvement of ..... I, 81; II, 1194
Fort San Jacinto, Galveston Harbor, Tex., harbor lines at ..... I, 40; IV, 2475
Fort Schuyler, N. Y., defenses at. *See* New York Harbor.
Fort Smallwood, Md., defenses at. *See* Baltimore Harbor.
Fort Totten, N. Y., post of ..... I, 36, 38, 1045
Fort Wadsworth, N. Y., defenses at. *See* New York Harbor.
Fort Washakie, Wyo., road to Buffalo Fork, Snake River ..... I, 721; VIII, 5453
Fox River, Wis.:
Examination and survey of Green Bay Harbor ..... I, 538; V, 3747, 3750
Improvement of ..... I, 536; V, 3712
Improvement of Green Bay Harbor ..... I, 524; V, 3657
Operating and care of locks and dams ..... I, 537; V, 3721
Frankford Creek, Pa., bridge obstructing ..... I, 703
Frankfort Harbor, Mich., improvement of ..... I, 565; V, 3925
Frankfort, Mo., removal of wreck in Marsh River ..... I, 62; II, 1100
French Broad River, Tenn.:
Improvement of ..... I, 463; V, 2944
Survey of ..... I, 468; V, 3018
Friend, Lottie K. (schooner), removal of wreck of, from Delaware Bay ..... I, 206; II, 1587
Fulton, Ark.:
Improvement of Red River above ..... I, 401; IV, 2480
Improvement of Red River below ..... I, 398; IV, 2480

G.

Galena River, Ill., operating and care of lock and dam ..... I, 433; IV, 2752
Galveston and Brazos Canal, Tex. (*see* Oyster Creek) ..... I, 396; IV, 2418, 2421
Galveston Bay and Harbor, Tex.:
Deepening channel from Galveston to Texas City ..... I, 386; IV, 2326
Defenses of ..... I, 6, 29, 958
Examination of bay ..... I, 398
Examination of inner harbor ..... I, 398
Harbor lines at Fort San Jacinto ..... I, 40; IV, 2475
Improvement of West Bay and mouths of adjacent streams ..... I, 389, 391; IV, 2331, 2334
Improvement of harbor ..... I, 384; IV, 2308
Improvement of ship channel and Buffalo Bayou to Houston ..... I, 386; IV, 2325, 2327, 2330
Removal of wreck in harbor ..... I, 394; IV, 2341
Survey of ..... I, 394; IV, 2309
Gardiners Point, N. Y., defenses at. *See* Long Island Sound.
Gasconade River, Mo., improvement by Missouri River Commission ..... I, 695; VII, 4935, 4946, 4948
Gauging:
Columbia River, Oreg. and Wash ..... I, 675; VI, 4368
Mississippi River and tributaries ..... I, 412; IV, 2540
Mississippi River at St. Paul, Minn ..... I, 441; IV, 2821
Northern and Northwestern Lakes ..... I, 715; VIII, 5319, 5402
Gauley River, W. Va., improvement of ..... I, 494; V, 3340
Gedney Channel, New York Harbor, N. Y.:
Improvement of ..... I, 161; II, 1459
Removal of wrecks ..... I, 166, 167; II, 1471, 1475

Genesee River, N. Y. (*see* Charlotte Harbor) ..... I, 612; VI, 4163
George Lake, St. Johns River, Fla. (*see* Volusia Bar) ..... I, 310; III, 1975
Georges River, Me., improvement of ..... I, 57; II, 1093
Georgetown, D. C. *See* Washington.
Georgetown Harbor, S. C.:
Examination and survey of Sampit River ..... I, 291; III, 1883, 1887, 1892
Improvement of (*see also* Winyah Bay) ..... I, 280, 281; III, 1850, 1851
Georgia, defenses of coast of ..... I, 6, 25, 917
Georgiana Slough, Sacramento River, Cal., bridge at Walnut Grove ..... I, 699
Gettysburg, Pa., memorial tablet to Abraham Lincoln (*see* Public buildings and grounds) ..... I, 710; VIII, 5227
Gettysburgh (canal boat), removal of wreck of ..... I, 159; II, 1421
Gillan, James (canal boat), removal of wreck of ..... I, 206; II, 1589
Glencove Harbor, N. Y., improvement of ..... I, 150; II, 1399
Gloucester Harbor, Mass., improvement of ..... I, 74; II, 1164
Goat Island Ledge, Portsmouth Harbor, N. H. (*see* Pull-and-be-damned Point) ..... I, 77; II, 1170
Golconda, Ill. (*see* Ohio River) ..... I, 469; V, 3085
Golden Gate, San Francisco Bay, Cal., examination, plan, and estimate for improvement of channel to Karquines Strait ..... I, 634; VI, 4258, 4260
Goshen Creek, N. J., improvement of ..... I, 204; II, 1585
Gosport Harbor, N. H. (*see* Isles of Shoals) ..... I, 77; II, 1172, 1175
Government Printing Office, Washington, D. C. (*see* Public buildings and grounds) ..... I, 710, VIII, 5227
Governors Island, New York Harbor, N. Y., removal of wreck below Castle Williams ..... I, 166; II, 1473
Gowanus Bay, Canal, and Creek, N. Y.:
Bay Ridge, Red Hook, and Buttermilk channels, improvement of ..... I, 163; II, 1464
Gowanus Canal (*see* Gowanus Bay) ..... I, 163; II, 1461
Gowanus Creek Channel, improvement of ..... I, 165; II, 1469
Grande, Boca, Fla., examination, plan, and estimate for improvement ..... I, 827; III, 2048, 2053
Grand Ecore, La., bridge across Red River ..... I, 698
Grand Haven Harbor, Mich., improvement of ..... I, 557; V, 3895
Grand Lake, La. (*see* Mermentau River) ..... I, 374; III, 2264
Grand Marais, Mich., improvement of harbor of refuge ..... I, 520; V, 3610
Grand Marais, Minn., improvement of harbor ..... I, 513; V, 3547
Grand Rapids Lock and Dam, Wabash River ..... I, 508; V, 3498
Grand River, La., improvement of ..... I, 869; III, 2251
Grand River, Mich.:
Improvement of ..... I, 558; V, 3899
Improvement of Grand Haven Harbor ..... I, 557; V, 3895
Grand River, Ohio (*see* Fairport Harbor) ..... I, 598; VI, 4070
Grasse River, N. Y., examination of ..... I, 619
Grasse, Sylvia de (steamer) wreck of (*see* Columbia River, below Tongue Point) ..... I, 670; VI, 4360
Grays Harbor, Wash., improvement of, including bar entrance ..... I, 678; VI, 4468
Great Kanawha River, W. Va. (*see* Kanawha):
Bridges across, report on Congressional bill providing for construction of ..... I, 40, VIII, 5103
Improvement of ..... I, 490; V, 3322
Operating and care of locks and dams ..... I, 492; V, 3325
Great Lakes:
Defenses of ..... I, 30, 973
Improvement of channels in waters connecting ..... I, 569; VI, 3947
Preservation of bench marks along Erie Canal, N. Y. ..... I, 715; VIII, 5402
Surveys and charts ..... I, 711; VIII, 5317
Water levels ..... I, 715; VIII, 5319, 5402
Great Pedee River, S. C.:
Examination of ..... I, 292
Improvement of ..... I, 279; III, 1847
Great Salt Pond, Block Island, R. I., improvement of ..... I, 109; II, 1276
Great Sodus Bay, N. Y., improvement of harbor ..... I, 614; VI, 4166
Great South Bay, N. Y., examinations from Fire Island Inlet to Patchogue ..... I, 160, 161; II, 1443
Green Bay Harbor, Fox River, Wis.:
Examination and survey ..... I, 588; V, 3747, 3750
Improvement of ..... I, 524; V, 3657
Green Bay, Mich., water levels at Escanaba ..... I, 715; VIII, 5402
Green Jacket Shoal, Providence River, R. I., removal of ..... I, 103; II, 1260

Greenleaf Bend, Mississippi River, Ill.:
Examination and survey for preventing break into Cache River ..... I, 431; IV, 2672, 2674
Prevention of break into Cache River ..... I, 429; IV, 2666
Green River, Ky.:
Examination, plan, and estimate for improvement ..... I, 512; V, 3542
Improvement above mouth of Big Barren River (Lock No. 5) ..... I, 510; V, 3501
Operating and care of locks and dams ..... I, 511; V, 3516
Reconstruction of Lock No. 2, at Rumsey ..... I, 509; V, 3501
Greenville Harbor, Miss. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Greenville, N. J., harbor lines at Jersey Flats, New York Harbor, opposite ..... I, 40; II, 1475
Greenwich Harbor, Conn., improvement of ..... I, 140; II, 1350
Grosse Isle, Mich. *See* Detroit River.
Grounds, public buildings and, District of Columbia ..... I, 710; VIII, 5227
Gulfport, Miss., improvement of channel to Ship Island Harbor ..... I, 355; III, 2216
Gulf States:
Removal of water hyacinth from Florida waters ..... I, 315; III, 1985
Removal of water hyacinth from waters of Louisiana ..... I, 377; III, 2270
Gun batteries ..... I, 6, 7, 35
Guyandot River, W. Va.:
Bridges across ..... I, 700
Examination of ..... I, 503; V, 3396
Improvement of ..... I, 495; V, 3343
Guyandot Valley Railway Company, bridge of ..... I, 700

H.

Hackensack City and River, N. J.:
Bridge of city ..... I, 700
Bridge of the Morris and Essex Railroad Company ..... I, 701
Hagan, John (barge), removal of wreck of ..... I, 254; II, 1738
Hahnemann, Samuel, monument to (*see* Public buildings and grounds) ..... I, 710; VIII, 5227, 5265
Hall, Richard (schooner), removal of wreck of ..... I, 159; II, 1421
Hampton Creek, Va., removal of wreck ..... I, 264; II, 1784
Hampton Roads, Va.:
Defenses of ..... I, 6, 11, 23, 886
Defenses of entrance to Chesapeake Bay at Cape Henry ..... I, 6
Examination and survey at Middle Ground Bar ..... I, 265; II, 1785, 1788
Harbor lines, establishment of ..... I, 40
Baltimore Harbor, Md ..... I, 40; II, 1693, 1697
Boston harbor, Mass ..... I, 40; II, 1225
Buffalo Harbor, N. Y ..... I, 40; VI, 4156
Cambridge, Mass ..... I, 40; II, 1225
Charles River, Mass ..... I, 40; II, 1225
Curtis Bay, Baltimore Harbor, Md ..... I, 40; II, 1697
Dog Island, St. Georges Sound, Fla ..... I, 40; III, 2158
Duluth Harbor, Minn ..... I, 40; V, 3642
East River, N. Y ..... I, 40; II, 1455, 1457
Elizabeth River, Va ..... I, 40; II, 1791
Fall River Harbor, Mass ..... I, 40; II, 1311
Fort San Jacinto, Galveston Harbor, Tex ..... I, 40; IV, 2475
Galveston Harbor, Tex ..... I, 40; IV, 2475
Greenville, N. J ..... I, 40; II, 1475
Hillsboro River, Fla ..... I, 40; III, 2084
Honolulu Harbor, Hawaiian Islands ..... I, 40; VIII, 5095
James River, Va ..... I, 40; II, 1761
Jersey Flats, Upper New York Bay, N. Y ..... I, 40; II, 1475
Kenosha Harbor, Wis ..... I, 40; V, 3776
Laporte, Tex ..... I, 40; IV, 2476
Mount Hope Bay, Mass ..... I, 40; II, 1311
Neuse River, N. C ..... I, 40; III, 1837
Newbern Harbor, N. C ..... I, 40; III, 1837
New Haven Harbor, Conn ..... I, 40; II, 1366
New London Harbor, Conn ..... I, 40; II, 1363
New York Harbor, N. Y ..... I, 40; II, 1455, 1457, 1475
Niagara River, N. Y ..... I, 40; VI, 4156, 4159
Norfolk Harbor, Va ..... I, 40; II, 1791
North Tonawanda, N. Y ..... I, 40; VI, 4159
Patapsco River, Md ..... I, 40; II, 1693, 1697

Harbor lines, establishment of—Continued.
Portland, Oreg ... I, 40; VI, 4456
Richmond Harbor, Va ... I, 40; II, 1761
Rockland Harbor, Me ... I, 40; II, 1138
St. Georges Sound, Fla ... I, 40; III, 2158
San Jacinto Bay, Tex ... I, 40; IV, 2476
San Jacinto, Fort, Galveston Harbor, Tex ... I, 40; IV, 2475
Stamford Harbor, Conn ... I, 40; II, 1368
Superior Harbor, Wis ... I, 40; V, 3642
Tampa Harbor, Fla ... I, 40; III, 2084
Thames River, Conn ... I, 40; II, 1363
Tonawanda (North), N. Y ... I, 40; VI, 4159
Trent River, N. C ... I, 40; III, 1837
Upper New York Bay, N. Y ... I, 40; II, 1475
Willamette River, Oreg ... I, 40; VI, 4456
Harbors and rivers. *See* Rivers and harbors.
Harlem River, N. Y.:
Improvement of ... I, 153; II, 1406
Removal of wreck at Mott Haven ... I, 159; II, 1421
Harlowe Creek or River, N. C., improvement of waterway via ... I, 270; III, 1806
Harrisonville Harbor, Ill., examination of ... I, 431
Hartford, Conn., improvement of Connecticut River below ... I, 119; II, 1328
Hat Slough, Wash. (*see* Puget Sound) ... I, 681; VI, 4477
Hatteras, Cape, N. C., harbor of refuge (*see* Cape Lookout) ... I, 276; III, 1829
Havre de Grace, Md.:
Examination of harbor ... I, 231
Improvement of Susquehanna River above and below ... I, 218; II, 1642
Hawaiian Islands:
Defenses for ... I, 6
Defenses for Pearl and Honolulu harbors ... I, 6, 7
Harbor lines in Honolulu Harbor ... I, 40; VIII, 5095
Improvement of Pearl Harbor ... I, 43
Hay Lake Channel, St. Marys River, Mich., improvement of ... I, 578; VI, 3969
Hector (schooner), removal of wreck of ... I, 110; II, 1281
Helena Harbor, Ark. (*see* Mississippi River Commission) ... I, 694; VII, 4525
Hell Gate, East River, N. Y., improvement of ... I, 152; II, 1403
Hempstead Harbor, N. Y. (*see* Glencove) ... I, 150; II, 1399
Hendersons Point, Portsmouth Harbor, N. H., examination at ... I, 78
Hendleys Ferry, Conecuh River, Ala., bridge at ... I, 697
Henry, Cape, Va., defenses of entrance to Chesapeake Bay at ... I, 6
Hero (canal boat), removal of wreck of ... I, 234; II, 1693
Herr Island, Allegheny River, Pa., construction of lock and dam ... I, 483; V, 3257
Highland Bayou, Tex., examination and survey ... I, 395; IV, 2410, 2412
Highland Park Bridge Company, bridge of ... I, 699
Highland Park, Pittsburg, Pa., bridge across Allegheny River ... I, 699
Hillsboro Bay and River, Fla.:
Harbor lines at Tampa ... I, 40; III, 2084
Improvement of ... I, 323; III, 2025
Hitch, Frank, bridge of ... I, 697
Hiwassee River, Tenn., examination and survey ... I, 468; V, 3010, 3016
Holland (Black Lake) Harbor, Mich., improvement of ... I, 557; V, 3891
Holmes Bayou, Miss. (*see* Pearl River, below Jackson and Rockport) ... I, 356; III, 2218
Holmes River, Fla., improvement of ... I, 336; III, 2116
Holston River, Tenn., examination and survey ... I, 469; V, 3058, 3063
Homochitto River, Miss., improvement of ... I, 382; III, 2280
Honolulu Harbor, Hawaiian Islands:
Defenses for ... I, 6, 7
Harbor lines ... I, 40; VIII, 5095
Hoquiam City and River, Wash., construction of bridge ... I, 700
Horn Island Harbor, Miss., improvement of ... I, 352; III, 2211
Horseshoe, Tail of the, Chesapeake Bay, removal of wreck on ... I, 264; II, 1783
Horses, sale of, when not needed ... I, 44
Housatonic River, Conn., improvement of ... I, 126; II, 1337
Houston River, La., bridge across ... I, 699
Houston, Tex., improvement of waterway to Galveston ... I, 386; IV, 2325, 2327, 2330
Howard University Reservoir, Washington, D. C., construction of ... I, 707; VIII, 5208
Howes George A. (schooner), removal of wreck of ... II, 1588
Hudson, Fla., examination and survey of bay at ... I, 327; III, 2066, 2069
Hudson, N. Y., removal of wreck in Hudson River near ... I, 187; II, 1516

Hudson River, N. Y.:
Coxsackie to Troy, improvement from ... I, 171; II, 1487
Peekskill Harbor, improvement of ... I, 176; II, 1498
Rondout Harbor, improvement of ... I, 175; II, 1496
Saugerties Harbor, examination, plan, and estimate for improvement ... I, 188; II, 1518
Saugerties Harbor, improvement of ... I, 174; II, 1494
Tarrytown Harbor, examination and survey ... I, 188; II, 1520, 1522
Wrecks, removal of ... I, 187; II, 1516, 1517
Humboldt County, Cal., bridge across Eureka Slough in ... I, 701
Humboldt Harbor and Bay, Cal., improvement of ... I, 632; VI, 4237
Huntington Harbor, N. Y., improvement of ... I, 149; II, 1397
Huntsdale, Mo., examination and survey of Missouri River at ... I, 448; IV, 2847, 2849
Hurd, W. B. (canal boat), removal of wreck of ... I, 187; II, 1516
Huron Harbor, Ohio, improvement of ... I, 593; VI, 4051
Huron Lake:
See also Northern and Northwestern Lakes.
Improvement of harbor of refuge at Sandbeach, Mich ... I, 578; VI, 3983
Water levels ... I, 715; VIII, 5319, 5402
Hyacinth, water:
Removal of, from Florida waters ... I, 315; III, 1985
Removal of, from Louisiana waters ... I, 377; III, 2270
Hyannis, Mass.:
Examination and survey of harbor ... I, 111; II, 1284, 1286
Improvement of harbor of refuge ... I, 94; II, 1234
Hydraulic mining in California ... I, 696; VIII, 5007

I.

Illinois and Mississippi Canal, Ill.:
Construction of ... I, 546; V, 3810
Examination of Rock River feeder for lock and dam ... I, 550
Operating and care ... I, 549; V, 3853
Illinois River, Ill.:
Bridges across, report on Congressional bill providing for construction of ... I, 40; VIII, 5103
Chicago Drainage Canal ... I, 42
Improvement of ... I, 545; V, 3798
Operating and care of locks and dams ... I, 546; V, 3805
Survey for extension of navigation to Lake Michigan ... I, 549; V, 3855
Indiana Chute, Falls of Ohio River, Ky., improvement of ... I, 503; V, 3463
Indian River Bay, Del., improvement of waterway via ... I, 217; II, 1642
Indian River, Fla., improvement of ... I, 312; III, 1982
Indian River Inlet, Fla. (*see* Indian River) ... I, 312; III, 1982
Individuals, occupancy of public structures by ... I, 40; VIII, 5085
Ingraham, J. D. (schooner), removal of wreck of ... I, 110; II, 1281
Injured employees, recommendation regarding aid to ... I, 44
Injury of public structures by private parties ... I, 40; VIII, 5085
Insular possessions, defenses for. *See* Fortifications.
Isabel, Point, Tex. (*see* Brazos Santiago Harbor) ... I, 397; IV, 2469
Isle of Wight Bay, Md., improvement of waterway via ... I, 217; II, 1642
Isles of Shoals, N. H., examination and survey for breakwater between Smutty Nose and Cedar Islands ... I, 77; II, 1172, 1175

J.

Jacksons Creek, Va., examination of ... I, 254; II, 1753
James River, Va.:
Examination and survey at Richmond ... I, 255; II, 1754, 1757
Harbor lines at Richmond ... I, 40; II, 1761
Improvement of ... I, 251; II, 1725
Protection of Jamestown Island ... I, 253; II, 1736
Removal of wreck at Richmond ... I, 254; II, 1738
Jamestown Island, James River, Va., protection of ... I, 253; II, 1736
Jane, Lydia (schooner), removal of wreck of ... I, 93; II, 1219
Jefferson, Tex., waterway to Shreveport, La. (*see* Cypress Bayou) ... I, 401; IV, 2502
Jekyl Creek, Ga., improvement of waterway via ... I, 303; III, 1953
Jennings, Mont., examination of Kootenai River to international boundary ... I, 693
Jersey Flats, Upper New York Bay, N. Y., harbor lines opposite Greenville, N. J ... I, 40; II, 1475
Johnsons Bayou, La., improvement of ... I, 377; III, 2268
Johnsons Creek, Conn. (*see* Bridgeport Harbor) ... I, 129; II, 1339

Jonesport, Me., improvement of Moosabec Bar ..... I, 46; II, 1075
Judith, Mont. (*see* Missouri River) ..... I, 444; IV, 2859
Judith, Point, R. I.:
Construction of harbor of refuge ..... I, 106; II, 1269
Improvement of pond entrance ..... I, 108; II, 1271
Judsonia, Ark., removal of wreck in Little Red River ..... I, 424; IV, 2613
Jupiter Inlet, Fla. (*see* Indian River) ..... I, 312; III, 1982

K.

Kalamazoo River, Mich.:
Bridge at New Richmond ..... I, 702
Improvement at Saugatuck ..... I, 555, 556; V, 3887, 3890
Kamiah, Idaho, bridge across Clearwater River near ..... I, 699
Kampsville Lock and Dam, Illinois River, Ill., operating and care ..... I, 546; V, 3805
Kanawha River, W. Va.:
Bridges across, report on Congressional bill providing for construction of ..... I, 40; VIII, 5103
Improvement of ..... I, 490; V, 3322
Operating and care of locks and dams ..... I, 492; V, 3325
Kansas City, Shreveport and Gulf Railway Company, bridge of ..... I, 699
Karquines Strait, Cal.:
Examination of channel to San Joaquin River ..... I, 634
Examination, plan, and estimate for improvement of channel to Golden Gate ..... I, 634; VI, 4258, 4260
Kempeska Lake, S. Dak., examination for reservoir dam ..... I, 451
Kenduskeag River, Me., examination of mouth ..... I, 63; II, 1108
Kennebec River, Me.:
Defenses of ..... I, 6, 13, 733
Examination and survey between Gardiner and Augusta ..... I, 64; II, 1121, 1127
Examination and survey of Parkers Head Harbor and Channel ..... I, 64; II, 1131, 1136
Improvement of ..... I, 58; II, 1095
Removal of wreck at Bath ..... I, 62; II, 1100
Kenosha Harbor, Wis.:
Examination of ..... I, 539; V, 3767
Harbor lines ..... I, 40; V, 3776
Improvement of ..... I, 534; V, 3706
Kenova, W. Va., bridge across Big Sandy River ..... I, 697
Kensington and Tacony Railroad, bridge of ..... I, 703
Kentucky River, Ky.:
Bridge across North Fork ..... I, 699
Bridge at Carrollton ..... I, 699
Improvement of ..... I, 500; V, 3363
Operating and care of locks and dams ..... I, 502; V, 3369
Kewaunee Harbor, Wis.:
Examination and survey ..... I, 538; V, 3752, 3755
Improvement of ..... I, 528; V, 3679
Keweenaw Bay and Point, Mich., improvement and operating and care of waterway to Lake Superior ..... I, 517, 518; V, 3598
Keyport Harbor, N. J.:
Improvement of ..... I, 183; II, 1511
Removal of wreck ..... I, 187; II, 1517
Key West Harbor, Fla.:
Defenses of ..... I, 6, 10, 25, 924
Improvement of, including entrance ..... I, 314; III, 1983
Kill van Kull, N. Y. and N. J.:
Examination and survey (*see* Arthur Kill) ..... I, 188; II, 1525, 1527
Improvement of (*see* Staten Island-New Jersey channel) ..... I, 178; II, 1502
King County, Wash.:
Bridge of, across Duwamish River ..... I, 700
Bridge of, across Snoqualmie River at Novelty ..... I, 699
Bridge of, across Snoqualmie River near Tolt ..... I, 700
Kingston Bay, Mass. (*see* Duxbury Harbor) ..... I, 89; II, 1209
Kingston, R. I.:
Construction of Point Judith harbor of refuge ..... I, 106; II, 1269
Improvement of entrance to Point Judith Pond ..... I, 108; II, 1271
Kinnickinnic River, Wis., bridge at Lincoln avenue, Milwaukee ..... I, 699
Kissimmee River, Fla., examination and survey to Gulf of Mexico ..... I, 327
Kootenai River, Idaho and Mont.:
Examination from Jennings, Mont., to international boundary ..... I, 693
Improvement from Bonners Ferry to international boundary ..... I, 691; VI, 4500

L.

La Crosse Harbor, Wis., improvement of ..... I, 433; IV, 2755
Lafourche Bayou, La., improvement of ..... I, 367; III, 2249
La Grange Bayou, Fla., improvement of ..... I, 336; III, 2116
Lagrange Lock and Dam, Illinois River, Ill., operating and care ... I, 546; V, 3805
Lake Shore and Michigan Southern Railway Company, bridge of ..... I, 699
Laporte, Tex., harbor lines in San Jacinto Bay at ..... I, 40; IV, 2476
Lapwai Creek, Idaho, bridge across Clearwater River near mouth of .... I, 700
Larchmont Harbor, N. Y., improvement of ..... I, 144; II, 1383
La Trappe River, Md., improvement of ..... I, 222; II, 1648
Lawrenceburg, Ind. (*see* Ohio River) ..... I, 469; V, 3085
Laws:
  Fifty-sixth Congress, first session, affecting Corps of Engineers .... VIII, 5459
  Governing the running of loose logs, etc., on certain streams ..... I, 43
  In aid of injured employees, recommendation regarding ..... I, 44
  Sale of personal property when not needed, recommendation as to ... I, 44
Leaf River, Miss., improvement of ..... I, 354; III, 2215
Leech Lake, Minn.:
  Construction of reservoir ..... I, 435; IV, 2786
  Operation and care of reservoir ..... I, 437; IV, 2800
  Survey of flowage lines of reservoir ..... I, 443
Lee, Druzilla B. (schooner), removal of wreck of ..... I, 206; II, 1589
Legislation. *See* Laws.
Lemon Bay, Fla., examination and survey of inside passage to Sarasota Bay ..... I, 327; III, 2054, 2060
Lemon Creek, N. Y. (*see* Staten Island-New Jersey channel) ..... I, 178; II, 1502
Levert, J. B., bridge of ..... I, 699
Levisa Fork, Big Sandy River, Ky.:
  Improvement of ..... I, 499; V, 3360
  Survey of ..... I, 503; V, 3400
Lewes, Del.:
  Construction of iron pier in Delaware Bay near ..... I, 196; II, 1574
  Improvement of waterway to Chincoteague Bay, Va ..... I, 217; II, 1642
Lewis River, Wash., improvement of ..... I, 673; VI, 4364
Licking River, Ky., survey of ..... I, 476; V, 3155
Lincoln, Abraham:
  Memorial tablet to, at Gettysburg, Pa ..... I, 710; VIII, 5227
  Repair of building in which he died ..... I, 710; VIII, 5227, 5236
Little Assawaman Bay, Del., improvement of waterway via ..... I, 217; II, 1642
Little Creek, Del., removal of wreck in ..... I, 229; II, 1660
Little Harbor, N. H., improvement of harbor of refuge ..... I, 68; II, 1151
Little Kanawha River, W. Va.:
  Improvement of ..... I, 489; V, 3317
  Operating and care of lock and dam ..... I, 490; V, 3319
Little Mud River, Ga., improvement of waterway via ..... I, 303; III, 1953
Little Narragansett Bay, R. I. and Conn. (*see* Pawcatuck River) ... I, 112; II, 1320
Little Pedee River, S. C., improvement of ..... I, 278; III, 1845
Little Pigeon River, Tenn., improvement of ..... I, 464; V, 2947
Little Red River, Ark., removal of wreck near Judsonia ..... I, 424; IV, 2613
Little Sodus Bay, N. Y., improvement of harbor ..... I, 614; VI, 4168
Little Tennessee River, Tenn., survey of ..... I, 469
Little Traverse Bay, Mich. (*see* Petoskey Harbor) ..... I, 568; V, 3932
Locks. *See* Canals *and* Waterways.
Logan, Gen. John A., statute of. (*see* Public buildings and grounds) ..... I, 710; VIII, 5227, 5265
Logs, regulations governing the running of, on certain streams ..... I, 43
Lone Tree Point, San Pablo Bay, Cal., examination, plan, and estimate for improvement of channel off ..... I, 634; VI, 4258, 4260
Long Bridge, Potomac River, D. C., rebuilding of ..... I, 236; II, 1702
Long Island, Charleston Harbor, S. C., bridge across Breach Inlet ..... I, 700
Long Island Sound, N. Y.:
  Defenses of eastern entrance ..... I, 6, 10, 11, 17, 814
  Removal of wreck off Port Chester ..... I, 159; II, 1421
Long Prairie River, Minn., examination of, and its sources ..... I, 443
Long Sault Island, St. Lawrence River, N. Y., examination at ..... I, 619
Long Tom River, Oreg.:
  Bridge at Bundys ..... I, 701
  Improvement of ..... I, 666; VI, 4346
Lookout, Cape, N. C., examination and survey for harbor of refuge. I, 276; III, 1829

Loper, R. L. (schooner), removal of wreck of ..... I, 264; II, 1784
Lorain Harbor, Ohio, improvement of ..... I, 594; VI, 4054
Louisiana, removal of water hyacinth from waters of ..... I, 377; III, 2270
Louisville and Nashville Railroad Company, bridge of ..... I, 699
Louisville and Portland Canal, Ky.:
  Enlargement of ..... I, 503; V, 3463
  Operating and care ..... I, 506; V, 3482
Louisville, Ky.:
  Improvement of Ohio River at ..... I, 503; V, 3463
  Operating and care of Louisville and Portland Canal ..... I, 506; V, 3482
Loutre, Pass a, Mississippi River:
  Closing crevasse in ..... I, 365; III, 2245
  Improving outlet at ..... I, 365; III, 2246
Lower Machodoc Creek, Va., improvement of ..... I, 242; II, 1714
Lower Middle Ground, Chesapeake Bay, removal of wreck on ..... I, 264; II, 1783
Lower New York Bay, N. Y. *See* New York Harbor.
Lubec Channel, Me., improvement of ..... I, 45; II, 1074
Luddington, Addie (schooner), removal of wreck of ..... I, 206; II, 1588
Ludington Harbor, Mich., improvement of ..... I, 562; V, 3916
Lumberton Branch, Rancocas River, N. J., improvement of ..... I, 198; II, 1578
Lunet (schooner), removal of wreck of ..... I, 110; II, 1281
Lydia Jane (schooner), removal of wreck of ..... I, 93; II, 1219
Lynchs River, S. C., examination and survey ..... I, 291; III, 1876, 1879
Lynn Harbor, Mass.:
  Examination of ..... I, 94
  Improvement of ..... I, 78; II, 1189
  Removal of wreck ..... I, 77; II, 1169

M.

Macedonia (steamship), removal of wreck of ..... II, 1516
Mackinac Harbor, Mich., examination and survey ..... I, 587; VI, 4008, 4010
McNeal, James (canal boat), removal of wreck of ..... I, 206; II, 1588
Maçon Bayou, La., improvement of ..... I, 406; IV, 2517
Madison, Ind.:
  Improvement of Ohio River at ..... I, 469; V, 3085
  Survey of Ohio River at ..... I, 476; V, 3215
Mahon Harbor, Del., examination of ..... I, 231
Maine, defenses on coast of ..... I, 6, 13, 733
Main Ship Channel, New York Harbor, N. Y., improvement of ..... I, 161; II, 1459
Malden, Mass., bridges across Mystic River to Boston ..... I, 700
Malden River, Mass., improvement of ..... I, 79; II, 1191
Mamaroneck Harbor, N. Y., improvement of ..... I, 143; II, 1381
Manasquan River, N. J., improvement of ..... I, 186; II, 1514
Manatee River, Fla., improvement of ..... I, 319; III, 2020
Manchac Bayou, La., improvement of ..... I, 363; III, 2243
Manchester Harbor, Mass., improvement of ..... I, 75; II, 1167
Manhasset (ferryboat), removal of wreck of ..... I, 264; II, 1783
Manhattan Borough, N. Y. *See* New York Harbor.
Manistee Harbor, Mich., improvement of ..... I, 563; V, 3919
Manitowoc Harbor, Wis.:
  Examinations and survey ..... I, 538, 539; V, 3761, 3764
  Improvement of ..... I, 529; V, 3683
Manokin River, Md.:
  Improvement of ..... I, 227; II, 1657
  Removal of wreck ..... I, 229; II, 1661
Mantua Creek, N. J., improvement of ..... I, 201; II, 1582
Maps:
  Military and other ..... I, 718, 721; VIII, 5445
  Northern and Northwestern Lakes ..... I, 711; VIII, 5317
Marblehead, Mass., repair of sea wall ..... I, 76; II, 1168
Marcushook, Pa., improvement of ice harbor in Delaware River ..... I, 195; II, 1574
Maria, Ellen (schooner), removal of wreck of ..... I, 77; II, 1169
Marinette, Wis.:
  Examination and survey of Menominee River ..... I, 538; V, 3739, 3742
  Improvement of Menominee Harbor and River ..... I, 522; V, 3650, 3653
Marquette Bay and Harbor, Mich.:
  Construction of harbor of refuge in bay ..... I, 519; V, 3608
  Improvement of harbor ..... I, 519; V, 3606
  Water levels ..... I, 715; VIII, 5402

Marsh River, Me., removal of wreck at Frankfort ..... I, 62; II, 1100
Marthas Vineyard, Mass.:
Examination at Cottage City ..... I, 111; II, 1293
Examination of Vineyard Haven for harbor of refuge ..... I, 111; II, 1289
Improvement of Vineyard Haven Harbor ..... I, 96; II, 1240
Removal of wrecks in Vineyard Haven Harbor ..... I, 110; II, 1281
Massachusetts, defenses of southeast coast ..... I, 6, 16, 791
Massena, N. Y., examination of Grasse River up to ..... I, 619
Matagorda Bay, Tex., examination of harbor at Alligator Head ..... I, 397; IV, 2462
Matanzas River, Fla. (*see* St. Augustine Harbor) ..... I, 311; III, 1981
Matawan Creek, N. J., improvement of ..... I, 183; II, 1510
Mattaponi River, Va., improvement of ..... I, 249; II, 1722
Mattawoman Shoal, Potomac River:
Improvement of ..... I, 238; II, 1706
Removal of wreck on ..... I, 254; II, 1739
Mattituck Harbor, N. Y., improvement of ..... I, 147; II, 1392
Maumee Bay and River, Ohio:
Bridge across river at Toledo ..... I, 699
Improvement of Toledo Harbor ..... I, 589; VI, 4022
Removal of wreck near outer entrance to bay ..... I, 603; VI, 4095
Maurice River, N. J.:
Examination and survey ..... I, 207; II, 1605, 1610
Removal of wreck ..... I, 206; II, 1589
May (canal boat), removal of wreck of ..... I, 206; II, 1589
Maysville, Ky.:
See also Ohio River ..... I, 469; V, 3085
Examination of Ohio River at ..... I, 477
Memorial bridge and boulevard to connect Washington, D. C., with Mount Vernon, Va ..... I, 43, 704; VIII, 5125
Memphis Harbor, Tenn.:
Examination by Mississippi River Commission ..... I, 694
Improvement by Mississippi River Commission ..... I, 694; VII, 4525
Menekaunee, Wis.:
Examination and survey of Menominee River ..... I, 538; V, 3739, 3742
Improvement of Menominee Harbor and River ..... I, 522; V, 3650; 3653
Menominee Harbor and River, Mich. and Wis.:
Examination and survey of river ..... I, 538; V, 3739, 3742
Improvement of harbor ..... I, 522; V, 3650
Improvement of river ..... I, 522; V, 3653
Mermentau River, La., improvement of, including tributaries ..... I, 374; III, 2264
Merrimac River, Mass.:
Improvement of ..... I, 70; II, 1155
Improvement of Newburyport Harbor ..... I, 69; II, 1153
Miami, Fla., examination of Biscayne Bay from, to the sea ..... I, 316; III, 1986
Mianus River, Conn., improvement of ..... I, 138; II, 1349
Michigan City, Ind.:
Improvement of inner harbor ..... I, 550; V, 3873
Improvement of outer harbor ..... I, 551; V, 3875
Removal of wreck at harbor entrance ..... I, 568; V, 3933
Michigan Lake:
See also Northern and Northwestern Lakes.
Canal to Sturgeon Bay, Wis., construction of harbor of refuge ..... I, 526; V, 3672
Canal to Sturgeon Bay, Wis., examination of ..... I, 539
Canal to Sturgeon Bay, Wis., improvement of ..... I, 525; V, 3659
Canal to Sturgeon Bay, Wis., operating and care ..... I, 526; V, 3666
Examination of channel to Stony Lake, Mich ..... I, 569; V, 3939
Survey of Illinois and Des Plaines rivers for extension of navigation to ..... I, 549; V, 3855
Water levels ..... I, 715; VIII, 5319, 5402
Middle Ground Bar, Hampton Roads, Va., examination and survey at ..... I, 265; II, 1785, 1788
Mifflin, Pa., bridge across Monongahela River ..... I, 697
Milan, Ill.:
Examination of canal feeder, Rock River, for lock and dam ..... I, 550
Operating and care of canal around Rock River ..... I, 549; V, 3853
Milford Harbor, Conn., examination, plan, and estimate for improvement ..... I, 141; II, 1356, 1359
Milford Haven, Va., improvement of harbor ..... I, 246; II, 1719
Military divisions and departments, reconnaissances and explorations in ..... I, 718; VIII, 5445

Miller, Laura (schooner), removal of wreck of ..... I, 603; VI, 4095
Mill River, New Haven, Conn. (*see* New Haven Harbor) ..... I, 123; II, 1333
Mill River, Stamford, Conn. *See* Stamford Harbor.
Milwaukee Bay, Harbor, and River, Wis.:
Bridge across Kinnickinnic River ..... I, 699
Bridge across Milwaukee River at Broadway ..... I, 699
Bridge across Milwaukee River, connecting Grand avenue and Wisconsin street ..... I, 701
Construction of harbor of refuge in bay ..... I, 531; V, 3695
Examination of harbor ..... I, 539
Improvement of harbor ..... I, 532; V, 3697
Water levels ..... I, 715; VIII, 5402
Mines, submarine ..... I, 5, 12, 35, 37
Minim Creek-Estherville Canal, S. C.:
Examination, plans, and estimates for extension of, to Alligator Creek or River ..... I, 291; III, 1894, 1897
Improvement of (*see* Santee River) ..... I, 283; III, 1856
Mining, hydraulic, in California ..... I, 696; VIII, 5007
Minnesota and Ontario Bridge Company, bridge of ..... I, 698
Minnesota River, Minn.:
Examination at St. Peter ..... I, 443; IV, 2840
Improvement of ..... I, 438; IV, 2812
Mispillion River, Del.:
Examination of ..... I, 231
Improvement of ..... I, 215; II, 1639
Mississippi River:
Beechridge, Ill., prevention of break at ..... I, 429; IV, 2666
Beechridge, Ill., examination and survey to prevent break at ..... I, 431; IV, 2672, 2674
Bellevue, Iowa, examination opposite ..... I, 434; IV, 2759
Brainerd, Minn., to Sandy Lake, survey from ..... I, 443
Bridges across, report on Congressional bill providing for construction of ..... I, 40; VIII, 5103
Caruthersville, Mo. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Chippewa River to West Newton Slough, regulations governing navigation from ..... I, 43
Crooked Slough, Ill., examination for dam ..... I, 434; IV, 2759
Delta Point, La. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Des Moines Rapids Canal and Dry Dock, operating and care ..... I, 433; IV, 2744
Dredge and snag boats above Missouri River, operation of ..... I, 431; IV, 2679
Gauging at St. Paul, Minn ..... I, 441; IV, 2821
Gauging, including tributaries ..... I, 412; IV, 2540
Greenleaf Bend, Ill., examination and survey to prevent break into Cache River ..... I, 431; IV, 2672, 2674
Greenleaf Bend, Ill., prevention of break into Cache River ..... I, 429; IV, 2666
Greenville Harbor, Miss. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Harrisonville Harbor, Ill., examination of ..... I, 431
Head of Passes to head waters, surveys from ..... I, 694; VII, 4525
Head of Passes to Ohio River, improvement, surveys, etc ..... I, 694; VII, 4525
Helena Harbor, Ark. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Hickman, Ky., to Slough Landing, Tenn., examination from ..... I, 695
Illinois and Mississippi Canal, Ill ..... I, 546, 549, 550; V, 3810, 3853
La Crosse Harbor, Wis., improvement of ..... I, 433; IV, 2755
Locks and dams between St. Paul and Minneapolis, Minn., construction of ..... I, 434; IV, 2768
Loutre, Pass a, closing crevasse in ..... I, 365; III, 2245
Loutre, Pass a, improving outlet at ..... I, 365; III, 2246
Memphis Harbor, Tenn., examination by Mississippi River Commission ..... I, 694
Memphis Harbor, Tenn., improvement by Mississippi River Commission ..... I, 694; VII, 4525
Minneapolis to St. Paul, Minn., construction of locks and dams ..... I, 434; IV, 2768
Missouri River to Ohio River, improvement from ..... I, 426; IV, 2631
Missouri River to St. Paul, Minn., improvement from ..... I, 432; IV, 2692
Natchez Harbor, Miss. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
New Madrid Harbor, Mo. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
New Orleans Harbor, La., defenses of ..... I, 6, 28, 952
New Orleans Harbor, La., improvement by Mississippi River Commission ..... I, 694; VII, 4525

Mississippi River—Continued.
Ohio River to Head of Passes, improvement, surveys, etc. I, 694; VII, 4525
Ohio River to Missouri River, improvement from I, 426; IV, 2631
Outlet, improvement of I, 365; III, 2246
Pass a Loutre, closing crevasse in I, 365; III, 2245
Pass a Loutre, improving outlet at I, 365; III, 2246
Pepin Lake and Village, Wis., examination and survey I, 434; IV, 2763, 2765
Pepin Lake and Village, Wis., improvement at I, 432; IV, 2692
Pokegama Falls, Minn., construction of reservoir I, 435; IV, 2786
Pokegama Falls, Minn., operating and care of reservoir I, 437; IV, 2800
Pokegama Falls, Minn., survey of flowage lines of reservoir I, 443
Quincy Bay, Ill., examination of I, 434; IV, 2756
Quincy Bay, Ill., improvement at I, 432; IV, 2692
Reservoirs at head waters, construction of I, 435; IV, 2786
Reservoirs at head waters, operating and care I, 437; IV, 2800
Reservoirs at head waters, surveys of flowage lines I, 443
Rockwood, Ill., examination and survey below I, 430; IV, 2667, 2669
St. Louis Harbor, Mo., improvement of I, 428; IV, 2664
St. Paul, Minn., gauging I, 441; IV, 2821
St. Paul, Minn., to Minneapolis, construction of locks and dams I, 434; IV, 2768
St. Paul, Minn., to Missouri River, improvement from I, 432; IV, 2692
Sandy Lake Dam to Brainerd, Minn., survey from I, 443
Slough Landing, Tenn., to Hickman, Ky., examination from I, 695
Snag and dredge boats above Missouri River, operation of I, 431; IV, 2679
Snags and wrecks below Missouri River, removal of I, 425; IV, 2621
South Pass, improvement of I, 41, 360, 366; III, 2225
Southwest Pass, plans and estimates for improvement of I, 365, 366, 383; III, 2287
Superior Lake, survey for canal to I, 521; V, 3613
Vidalia Harbor, La. (*see* Mississippi River Commission) I, 694; VII, 4525
Wagners Landing, Ill., examination and survey I, 430; IV, 2667, 2669
West Newton Slough to Chippewa River, regulations governing navigation from I, 43
Wrecks, etc., above Missouri River, removal of I, 431; IV, 2679
Wrecks, etc., below Missouri River, removal of I, 425; IV, 2621
Mississippi River Commission I, 694; VII, 4525
Mississippi Sound, Miss.:
Defenses of I, 27, 943
Improvement of channel from Gulfport to Ship Island Harbor I, 355; III, 2216
Improvement of Horn Island Harbor I, 352; III, 2211
Improvement of Ship Island Pass I, 355; III, 2216
Missouri River:
Bridge at St. Charles, Mo I, 698
Examination and survey at Huntsdale, Mo I, 443; IV, 2847, 2849
Examination and survey at Napoleon, Mo I, 443; IV, 2852, 2855
Improvement from Stubbs Ferry, Mont., to Sioux City, Iowa I, 444; IV, 2859
Improvement, surveys, etc., below Sioux City, Iowa I, 695; VII, 4935
Snagging upper river I, 450; IV, 2882
Missouri River Commission I, 695; VII, 4935
Mobile County, Ala., bridge of I, 700
Mobile Harbor and River, Ala.:
Bridge across Tensas River near I, 699
Bridge across Three-mile Creek near I, 700
Defenses of I, 6, 27, 943
Examination of bar below Fort Morgan I, 360
Improvement of harbor I, 344; III, 2161
Removal of wrecks in harbor I, 359; III, 2223
Moccasin Bend, Tennessee River, Tenn.:
Examination for canal I, 468; V, 3005
Improvement of (*see* Tennessee River, below Chattanooga) I, 460; V, 2912
Moccasin River (Contentnia Creek), N. C., improvement of I, 268; III, 1801
Mokelumne River, Cal., improvement of I, 627; VI, 4226
Monongahela River, W. Va. and Pa.:
Bridges across, report upon Congressional bill providing for construction of I, 40; VIII, 5103
Bridge between Mifflin and Rankin, Pa I, 697
Construction of locks and dams between Morgantown and Fairmont, W. Va I, 477; V, 3225
Improvement at Locks Nos. 3 and 6 I, 478; V, 3228
Improvement of Pittsburg Harbor I, 481; V, 3254
Operating and care of locks and dams I, 480; V, 3233

Moosabec Bar, Me., improvement of ..... I, 46; II, 1075
Monroe, Fort, Va., defenses at. *See* Hampton Roads.
Monroe Harbor, Mich., improvement of ..... I, 588; VI, 4019
Morgan Canal, Tex.:
Improvement of waterway via ..... I, 386; IV, 2325, 2327
Operating and care ..... I, 388; IV, 2328
Morgan, Fort, Ala., examination of bar below, in Mobile Harbor ..... I, 360
Morris and Essex Railroad Company, bridge of ..... I, 701
Mortar batteries ..... I, 6, 7, 35
Mosquito Creek Canal, S. C. (*see* Santee River) ..... I, 283; III, 1856
Mott Haven, New York, N. Y., removal of wreck in Harlem River ..... I, 159; II, 1421
Mound City, Ill. *See* Cache River, Ill., *and* Ohio River.
Mount Desert, Me., construction of breakwater ..... I, 47; II, 1079
Mount Hope Bay, Mass.:
Harbor lines at Fall River ..... I, 40; II, 1311
Improvement of (*see* Fall River Harbor) ..... I, 104; II, 1263
Mount Pleasant shore, Charleston, S. C., improvement at ..... I, 287; III, 1867
Mount Vernon, Va., memorial bridge and boulevard to connect with Washington, D. C ..... I, 43, 704; VIII, 5125
Mud Lake, La. (*see* Mermentau River) ..... I, 374; III, 2264
Mud River, Ga., improvement of waterway via ..... I, 303; III, 1953
Mules, sale of, when not needed ..... I, 44
Murderkill River, Del., improvement of ..... I, 213; II, 1637
Muscle Shoals Canal, Tennessee River, Ala., operating and care ..... I, 463; V, 2934
Muskegon Harbor and River, Mich.:
Examination of harbor ..... I, 569
Examination of river ..... I, 569; V, 3934
Improvement of harbor ..... I, 559; V, 3905
Muskingum River, Ohio:
Improvement of ..... I, 487; V, 3297
Operating and care of locks and dams ..... I, 488; V, 3300
Mystic River, Conn., improvement of ..... I, 115; II, 1323
Mystic River, Mass.:
Bridges between Boston and Chelsea ..... I, 698
Bridges between Boston and Malden ..... I, 700
Improvement of ..... I, 79; II, 1191
Improvement of, below mouth of Island End River ..... I, 80; II, 1193

N.

Nandua Creek, Va., improvement of ..... I, 260; II, 1771
Nansemond River, Va., improvement of ..... I, 257; II, 1765
Nanticoke River, Del. and Md., improvement of ..... I, 224; II, 1652
Nantucket, Mass., construction of harbor of refuge ..... I, 95; II, 1236
Napa River, Cal.:
Examination, plan, and estimate for improvement ..... I, 633; VI, 4253, 4255
Improvement of ..... I, 630; VI, 4234
Napoleon, Mo., examination and survey of Missouri River at ..... I, 443; IV, 2852, 2855
Narragansett Bay, R. I.:
Defenses of ..... I, 6, 12, 16, 798
Examination of Ohio Reef ..... I, 112
Improvement of ..... I, 102; II, 1257
Narraguagus River, Me., improvement of ..... I, 47; II, 1077
Narrows of Lake Champlain, N. Y. and Vt., improvement of ..... I, 170; II, 1485
Natalbany River, La. (*see* Tickfaw) ..... I, 362; III, 2241
Natchez Harbor, Miss. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Natchitoches Railway and Construction Company, bridge of ..... I, 698
Navesink River, N. J. (*see* Shrewsbury) ..... I, 185; II, 1513
Navigable waters. *See* Bridges, Rivers and harbors, *and* Wrecks.
Neah Bay, Wash., examination and survey ..... I, 692; VI, 4502, 4504
Neches River, Tex., improvement of ..... I, 378; III, 2272
Negro Cut, Indian River Inlet, Fla. (*see* Indian River) ..... I, 312; III, 1982
Neuse River, N. C.:
Harbor lines at Newbern ..... I, 40; III, 1837
Improvement of ..... I, 269; III, 1804
Improvement of waterway via ..... I, 270; III, 1806
Neville Island, Ohio River, Pa., bridges at ..... I, 701

Newark Bay, N. J.:
Examination and survey of Arthur Kill, including ..... I, 188; II, 1525, 1527
Examination and survey of Passaic Piver, including ..... I, 188; II, 1530, 1536, 1543, 1547
Improvement of (*see* Staten Island–New Jersey channel) ..... I, 178; II, 1502
Removal of wreck ..... I, 187; II, 1516
Newaygo, Mich., examination of Muskegon River from Muskegon Lake to ..... I, 569; V, 3934
New Baltimore, N. Y., removal of wreck in Hudson River ..... I, 187; II, 1516
New Bedford Harbor, Mass.:
Defenses of ..... I, 6, 16, 791
Examination and survey ..... I, 111; II, 1295, 1297
Improvement of ..... I, 98; II, 1245
Newbern, N. C.:
Examination of Trent River at and above ..... I, 277
Harbor lines in Trent and Neuse rivers ..... I, 40; III, 1837
Improvement of Neuse River ..... I, 269; III, 1804
Improvement of Trent River ..... I, 268; III, 1802
Improvement of waterway to Beaufort, N. C ..... I, 270; III, 1806
Newburyport Harbor, Mass., improvement of ..... I, 69; II, 1153
New Haven Harbor, Conn.:
Bridge across West River at Kimberly avenue ..... I, 702
Construction of breakwaters ..... I, 125; II, 1336
Harbor lines ..... I, 40; II, 1366
Improvement of ..... I, 123; II, 1333
New Jersey-Staten Island channel:
Examination and survey (*see* Arthur Kill) ..... I, 188; II, 1525, 1527
Improvement of ..... I, 178; II, 1502
New Liberty, Ill.:
See also Ohio River ..... I, 469; V, 3085
Examination and survey of Ohio River at ..... I, 476; V, 3191, 3196
New London Harbor, Conn.:
Defenses of ..... I, 6, 10, 11, 17, 814
Harbor lines in Thames River ..... I, 40; II, 1363
Improvement of (*see* Thames River) ..... I, 117; II, 1325
Survey of ..... I, 141; II, 1351
New Madrid Harbor, Mo. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
New Orleans Harbor, La.:
Defenses of ..... I, 6, 28, 952
Improvement by Mississippi River Commission ..... I, 694; VII, 4525
Newport Harbor, R. I.:
Defenses of ..... I, 6, 12, 16, 791
Improvement of ..... I, 105; II, 1265
Newport River, N. C.:
Improvement of Beaufort Harbor ..... I, 271; III, 1808
Improvement of waterway from Beaufort to New River ..... I, 271; III, 1810
Improvement of waterway from Newbern to Beaufort ..... I, 270; III, 1806
New Richmond, Mich., bridge across Kalamazoo River ..... I, 702
New River, N. C.:
Improvement of ..... I, 272; III, 1812
Improvement of waterway to Beaufort, N. C ..... I, 271; III, 1810
New Rochelle Harbor, N. Y., examination of, including plan and estimate for improving Echo Bay ..... I, 160; II, 1423, 1429
New Shoreham, Block Island, R. I.:
Construction of harbor of refuge ..... I, 108; II, 1272
Improvement of Great Salt Pond ..... I, 109; II, 1276
Newtown Creek, N. Y., improvement of ..... I, 155; II, 1411
New York Bay Railroad Company, bridge of ..... I, 701
New York Harbor, N. Y.:
Ambrose Channel, improvement of ..... I, 161; II, 1459
Arthur Kill, examination and survey ..... I, 188; II, 1525, 1527
Arthur Kill, improvement of (*see* Staten Island-New Jersey channel) ..... I, 178; II, 1502
Battery, the, removal of wreck off ..... I, 166; II, 1473
Bay Ridge Channel, improvement of ..... I, 163; II, 1464
Bayside Channel, improvement of ..... I, 161; II, 1459
Bridge No. 3, across East River ..... I, 700
Bronx River, improvement of ..... I, 146; II, 1389
Buttermilk Channel, examination of ..... I, 167
Buttermilk Channel, improvement of ..... I, 163; II, 1464

New York Harbor, N. Y.—Continued.
Castle Williams, removal of wreck below ..... I, 166; II, 1473
Coenties Reef, East River, examination and survey ..... I, 160; II, 1435, 1439
Coenties Reef, East River, improvement of ..... I, 152; II, 1403
Defenses of ..... I, 6, 10, 11, 12, 19, 827
Diamond Reef, East River, examination and survey ..... I, 160; II, 1435, 1439
Diamond Reef, East River, improvement of ..... I, 152; II, 1403
East (Ambrose) Channel, improvement of ..... I, 161; II, 1459
East River, bridge No. 8 ..... I, 760
East River, examination and survey of Diamond and Coenties reefs ..... I, 160; II, 1435, 1439
East River, harbor lines ..... I, 40; II, 1455, 1457
East River, improvement of ..... I, 152; II, 1403
East River, improvement of Wallabout Channel ..... I, 156; II, 1413
East River, removal of wreck in ..... II, 1422
Flushing Bay, improvement of ..... I, 151; II, 1401
Flynns Knoll, removal of wreck ..... I, 166; II, 1472
Gedney Channel, improvement of ..... I, 161; II, 1459
Gedney Channel, removal of wrecks ..... I, 166, 167; II, 1471, 1475
Governors Island, removal of wreck below Castle Williams ..... I, 166; II, 1473
Gowanus Bay and Canal, improvement of ..... I, 163; II, 1464
Gowanus Creek Channel, improvement of ..... I, 165; II, 1469
Greenville, N. J., harbor lines at Jersey Flats, opposite ..... I, 40; II, 1475
Harbor lines in East River and at Jersey Flats ..... I, 40; II, 1455, 1457, 1475
Harlem River, improvement of ..... I, 153; II, 1406
Harlem River, removal of wreck at Mott Haven ..... I, 159; II, 1421
Hell Gate, East River, improvement of ..... I, 152; II, 1403
Hudson River, removal of wreck ..... I, 187; II, 1517
Improvement of ..... I, 161; II, 1459
Jersey Flats, harbor lines opposite Greenville, N. J ..... I, 40; II, 1475
Kill van Kull, examination and survey (*see* Arthur Kill) ..... I, 188; II, 1525, 1527
Kill van Kull, improvement of (*see* Staten Island-New Jersey channel) ..... I, 178; II, 1502
Lemon Creek (*see* Staten Island-New Jersey channel) ..... I, 178; II, 1502
Main Ship Channel, improvement of ..... I, 161; II, 1459
Mott Haven, removal of wreck in Harlem River ..... I, 159; II, 1421
Narrows to the sea, improvement from ..... I, 161; II, 1459
Newark Bay, examination and survey of Arthur Kill, including ..... I, 188; II, 1525, 1527
Newark Bay, examination and survey of Passaic River, including ..... I, 188; II, 1530, 1536, 1543, 1547
Newark Bay, improvement of (*see* Staten Island-New Jersey channel) ..... I, 178; II, 1502
Newark Bay, removal of wreck ..... I, 187; II, 1516
Newtown Creek, improvement of ..... I, 155; II, 1411
Red Hook Channel, improvement of ..... I, 163; II, 1464
Sandy Hook, N. J., defenses at ..... I, 10, 19, 839
Spuyten Duyvil Creek (*see* Harlem River) ..... I, 153; II, 1406
Staten Island-New Jersey channel, examination and survey (*see* Arthur Kill) ..... I, 188; II, 1525, 1527
Staten Island-New Jersey channel, improvement of ..... I, 178; II, 1502
Staten Island Sound. (*See* Arthur Kill.)
Supervision of ..... I, 693; VI, 4513
Swash Channel, removal of wreck ..... I, 167; II, 1474
Totten, Fort, post of ..... I, 36, 38, 1045
Upper Bay, harbor lines at Jersey Flats ..... I, 40; II, 1475
Wallabout Channel, improvement of ..... I, 156; II, 1413
Willets Point ..... I, 36, 37, 1045
Williams, Castle, removal of wreck below ..... I, 166; II, 1473
Niagara River, N. Y.:
Buffalo Harbor, improvement of ..... I, 606; VI, 4113
Erie Basin and Black Rock Harbor, examination of Lake Erie entrance to ..... I, 611
Erie Basin and Black Rock Harbor, improvement of Buffalo entrance to ..... I, 608; VI, 4135
Examination and survey of Tonawanda Harbor ..... I, 611; VI, 4152, 4155
Harbor lines at Buffalo ..... I, 40; VI, 4156
Harbor lines at North Tonawanda ..... I, 40; VI, 4159
Tonawanda Harbor and, improvement of ..... I, 609; VI, 4138
Tonawanda to Port Day, improvement from ..... I, 610; VI, 4144

Nome City, Alaska, bridge across Snake River ..... I, 698
Nomini Creek, Va., improvement of ..... I, 241; II, 1711
Nooksak River, Wash. (*see* Puget Sound) ..... I, 681; VI, 4477
Norfolk Harbor, Va.:
Bridge across Tanners Creek, near ..... I, 700
Defenses of Hampton Roads ..... I, 6, 11, 23, 886
Examination at vicinity of pier of Southern Railway Company ..... I, 265
Harbor lines ..... I, 40; II, 1791
Improvement of, and its approaches ..... I, 255; II, 1763
Improvement of waterway to Albemarle Sound, N. C., via Currituck Sound ..... I, 262; II, 1778
Improvement of waterway to sounds of North Carolina, via Pasquotank River ..... I, 261; II, 1773
Improvement of Western Branch, Elizabeth River ..... I, 256; II, 1765
Removal of wrecked cars from Sewall Point Channel, Elizabeth River ..... I, 264; II, 1784
Removal of wreck in Southern Branch, Elizabeth River ..... I, 264; II, 1783
Norfolk Railway and Light Company, bridge of ..... I, 700
Norris Cut, Biscayne Bay, Fla., examination, plan, and estimate for improvement ..... I, 316; III, 1986
North Branch, Chicago River, Ill. *See* Chicago Harbor and River.
North Branch, Santee River, S. C. *See* Santee River.
North Carolina:
Defenses of coast ..... I, 6, 11, 12, 23, 897
Examination of waterway from South Mills to and including Beaufort and Ocracoke inlets ..... I, 265, 277
Improvement of waterway from Albemarle Sound to Norfolk, Va., via Currituck Sound ..... I, 262; II, 1778
Improvement of waterway from Pamlico Sound to Norfolk, Va., via Pasquotank River ..... I, 261; II, 1773
Northeast Branch, Cape Fear River, N. C., improvement of ..... I, 273; III, 1815
Northern and Northwestern Lakes:
Defenses of ..... I, 80, 978
Improvement of channels in waters connecting ..... I, 569; VI, 3947
Preservation of bench marks along Erie Canal, N. Y ..... I, 715; VIII, 5402
Surveys and charts ..... I, 711; VIII, 5317
Water levels ..... I, 715; VIII, 5319, 5402
North Fork, Kentucky River, Ky., bridge across ..... I, 699
North Fork, Skagit River, Wash. (*see* Puget Sound) ..... I, 681; VI, 4477
North Hero Island Channel, Lake Champlain, Vt., improvement of ..... I, 167
North Landing River, Va., improvement of waterway via ..... I, 262; II, 1778
North River, Mass. (*see* Scituate Harbor) ..... I, 88; II, 1206
North River, N. C., improvement of waterway via ..... I, 262; II, 1778
North River, Wash. (*see* Willapa River and Harbor) ..... I, 676; VI, 4463
North Tonawanda, N. Y.:
Harbor lines at ..... I, 40; VI, 4159
Improvement of Tonawanda Harbor ..... I, 609; VI, 4138
Norwalk Harbor, Conn., improvement of ..... I, 133; II, 1344
Novelty, Wash., bridge across Snoqualmie River ..... I, 699
Noxubee River, Miss., improvement of ..... I, 351; III, 2208

O.

Oak Creek, Wis. (*see* South Milwaukee Harbor) ..... I, 533; V, 3701
Oakland Harbor, Cal.:
Defenses of San Francisco ..... I, 6, 12, 32, 980
Examination of ..... I, 634
Improvement of ..... I, 626; VI, 4218
Obion River, Tenn., improvement of ..... I, 451; IV, 2887
Obstructions to navigation. *See* Bridges *and* Wrecks.
Occoquan Creek, Va., improvement of ..... I, 239; II, 1709
Occupancy of public structures by private parties ..... I, 40; VIII, 5085
Ocklawaha River, Fla., improvement of ..... I, 310; III, 1980
Ocklockonnee River, Fla., examination, plan, and estimate for improvement ..... I, 343; III, 2146, 2152
Ocmulgee River, Ga., improvement of ..... I, 301; III, 1944
Oconee River, Ga., improvement of ..... I, 299; III, 1942
Oconto Harbor, Wis.:
Examination of ..... I, 538; V, 3745
Improvement of ..... I, 528; V, 3654

Ocracoke Inlet, N. C.:
Examination of waterway from South Mills to and including ..... I, 265, 277
Improvement of ..... I, 265; III, 1793
Office of the Chief of Engineers, officers on duty in ..... I, 723
Ogdensburg Harbor, N. Y., improvement of ..... I, 618; VI, 4177
Ohio and Kentucky Railway Company, bridge of ..... I, 699
Ohio Reef, Narragansett Bay, R. I., examination of ..... I, 112
Ohio River:
Bridges across, report upon Congressional bill providing for construction of ..... I, 40; VIII, 5103
Bridges at Neville Island and Fleming Park, Pa ..... I, 701
Davis Island Dam, Pa., operating and care ..... I, 473; V, 3140
Falls of, including Indiana Chute, improvement of ..... I, 503; V, 3463
Gauging (*see* Mississippi River) ..... I, 412; IV, 2540
General improvement ..... I, 469; V, 3085
Louisville and Portland Canal, Ky., enlargement of ..... I, 503; V, 3463
Louisville and Portland Canal, Ky., operating and care ..... I, 506; V, 3482
Madison, Ind., survey at ..... I, 476; V, 3215
Marietta, Ohio, to the Big Miami, survey from ..... I, 476; V, 3201
Maysville, Ky., examination at ..... I, 477
Mound City to Cairo, Ill., examination from ..... I, 476; V, 3185
Movable dams, construction of ..... I, 473; V, 3146
New Liberty, Ill., examination and survey ..... I, 476; V, 3191, 3196
Pittsburg Harbor, Pa., improvement of ..... I, 481; V, 3254
Sand Island, Ky., examination for acquisition of ..... I, 513
Snag boat, operation of ..... I, 472; V, 3129
Ohio Valley Electric Railway Company, bridge of ..... I, 697
Okanogan River, Wash., improvement of ..... I, 689; VI, 4489
Okechobee Lake, Fla., examination and survey of waterway via ..... I, 327
Oldmans Creek, N. J., examination and survey ..... I, 207; II, 1598, 1602
Old Orchard Shoal Light, Raritan Bay, N. J., removal of wreck ..... I, 187; II, 1516
Old Swan (schooner), removal of wreck of ..... I, 62; II, 1100
Old Tampa Bay, Fla. *See* Tampa Bay.
Olympia Harbor, Wash., improvement of ..... I, 683; VI, 4481
Ontario Lake:
See also Northern and Northwestern Lakes.
Water levels ..... I, 715; VIII, 5319, 5402
Ontonagon Harbor, Mich., improvement of ..... I, 517; V, 3595
Onward (schooner), removal of wreck of ..... I, 603; VI, 4096
Orange, Conn., bridge of town of ..... I, 702
Orange Mills Flats, St. Johns River, Fla., improvement at ..... I, 309; III, 1972
Orange River, Fla., examination and survey to the Gulf, via the Caloosahatchee ..... I, 326; III, 2032, 2035
Osage River, Mo., improvement by Missouri River Commission ..... I, 695; VII, 4935, 4944, 4947
Oswegatchie River, N. Y. (*see* Ogdensburg Harbor) ..... I, 618; VI, 4177
Oswego Harbor, N. Y.:
Improvement of ..... I, 615; VI, 4170
Water levels ..... I, 715; VIII, 5402
Otter Creek, Vt., improvement of ..... I, 169; II, 1484
Otter Tail Lake and River, Minn., survey of ..... I, 442; IV, 2830
Ouachita River, Ark. and La.:
Examination of Camden Harbor, Ark ..... I, 415
Improvement of ..... I, 402; IV, 2503
Survey for locks and dams ..... I, 414; IV, 2544
Oyster Creek, Tex., examination and survey ..... I, 396; IV, 2418, 2421

P.

Pacific (sloop), removal of wreck of ..... I, 187; II, 1517
Paducah, Ky.:
See also Tennessee River, below Chattanooga ..... I, 460; V, 2916
Survey of Tennessee River at ..... I, 477; V, 3219
Pagan River, Va., examination of ..... I, 265
Palmer, Augustus (schooner), removal of wreck of ..... I, 264; II, 1783
Pamlico River and Sound, N. C.:
Examination of waterway from South Mills to and including Beaufort and Ocracoke inlets ..... I, 265, 277
Improvement of river ..... I, 267; III, 1798
Improvement of waterway from Pamlico Sound to Norfolk, Va. I, 261; II, 1773

Pamunkey River, Va., improvement of ..... I, 250; II, 1724
Parkers Ferry, Conecuh River, Ala., bridge at ..... I, 697
Parkers Head Harbor and Channel, Kennebec River, Me., examination and survey ..... I, 64; II, 1131, 1136
Pascagoula Harbor and River, Miss.:
Improvement of river ..... I, 351; III, 2209
Improvement of river, including Horn Island Harbor ..... I, 352; III, 2211
Removal of wreck in harbor ..... I, 359; III, 2223
Pasquotank River, N. C.:
Examination of waterway from South Mills to and including Beaufort and Ocracoke inlets ..... I, 265, 277
Improvement of waterway via ..... I, 261; III, 1773
Passaic River, N. J.:
Bridge across ..... I, 701
Examination and survey ..... I, 188; II, 1530, 1536, 1543, 1547
Improvement of ..... I, 177; II, 1500
Pass a Loutre, Mississippi River:
Closing crevasse in ..... I, 365; III, 2245
Improving outlet at ..... I, 365; III, 2246
Patapsco River, Md.:
Defenses of Baltimore ..... I, 6, 11, 21, 866
Harbor lines in Baltimore Harbor, Curtis Bay, and ..... I, 40; II, 1693, 1697
Improvement at Spring Garden, Baltimore ..... I, 233; II, 1693
Improvement of channel to Curtis Bay ..... I, 233; II, 1692
Improvement of, including channel to Baltimore ..... I, 231; II, 1687
Removal of wreck ..... I, 234; II, 1693
Patchogue River, N. Y.:
Examination, plan, and estimate for improvement ..... I, 160; II, 1446, 1450
Examinations from Fire Island Inlet to Patchogue ..... I, 160, 161; II, 1443
Improvement of ..... I, 158; II, 1419
Paterson, N. J., examination and survey of Passaic River up to ..... I, 188; II, 1530, 1536, 1543, 1547
Patuxent River, Md., examination and survey ..... I, 254; II, 1739, 1741
Pawcatuck River, R. I. and Conn., improvement of ..... I, 112; II, 1320
Pawtucket River, R. I.:
Examinations and survey ..... I, 112; II, 1302, 1304
Improvement of ..... I, 101; II, 1254
Peace Creek, Fla.:
Examination, plan, and estimate for improvement of Charlotte Harbor ..... I, 327; III, 2048, 2053
Improvement of ..... I, 317; III, 2017
Pearl Harbor, Hawaiian Islands:
Defenses for ..... I, 6, 7
Improvement of ..... I, 43
Pearl River, Miss.:
Below Jackson and Rockport, improvement ..... I, 356; III, 2218
Carthage to Jackson, improvement from ..... I, 357; III, 2220
Edinburg to Carthage, improvement from ..... I, 358; III, 2221
Mouth, improvement of ..... I, 356; III, 2217
Pedee rivers, S. C.:
Examination of Great Pedee ..... I, 292
Improvement of Great Pedee ..... I, 279; III, 1847
Improvement of Little Pedee ..... I, 278; III, 1845
Peekskill Harbor, N. Y., improvement of ..... I, 176; II, 1498
Pend Oreille River, Wash., improvement of ..... I, 690; VI, 4494
Pennsylvania Railroad Company, bridge of ..... I, 703
Penobscot River, Me.:
Defenses of ..... I, 6, 13, 733
Examination and survey of Bucksport Harbor ..... I, 63; II, 1103, 1107
Examination at and near Bucksport Narrows ..... I, 63; II, 1101
Improvement of ..... I, 52; II, 1086
Penokee (schooner), removal of wreck of ..... I, 167; II, 1474
Pensacola Harbor, Fla.:
Defenses of ..... I, 6, 26, 939
Improvement of ..... I, 337; III, 2118
Pentwater Harbor, Mich., improvement of ..... I, 561; V, 3913
Pepin Lake and Village, Mississippi River, Wis.:
Examination and survey at ..... I, 434; IV, 2763, 2765
Improvement at ..... I, 432; IV, 2692

Pequonnock River, Conn. (*see* Bridgeport Harbor) ..... I, 129; II, 1339
Pere Marquette Lake, Mich. (*see* Ludington Harbor) ..... I, 562; V, 3916
Pere Marquette Railroad, bridge of ..... I, 702
Personal property, sale of, when not needed ..... I, 44
Persons, injured, recommendation in aid of ..... I, 44
Petaluma Creek, Cal., improvement of ..... I, 631; VI, 4236
Petoskey Harbor, Mich., improvement of ..... I, 568; V, 3932
Phalia (Falia), Bogue, La., improvement of ..... I, 361; III, 2240
Philadelphia, Pa.:
Defenses of ..... I, 6, 20, 35, 842
Improvement of Delaware River at ..... I, 193; II, 1566
Improvement of Schuylkill River ..... I, 193; II, 1570
Plan and estimate for improvement of Delaware River, below Christian street ..... I, 207; II, 1615
Removal of wreck in Delaware River, off Snyder avenue ..... I, 206; II, 1588
Removal of wrecks in Schuylkill River ..... I, 206; II, 1588, 1589
Philippines, division of the, reconnaissances and explorations ..... I, 718; VIII, 5445
Pierre and Fort Pierre, S. Dak. (*see* Missouri River) ..... I, 444; IV, 2859
Piers, public, occupancy of, by private parties ..... I, 40; VIII, 5085
Pigeon Bayous, La., improvement of ..... I, 360; III, 2251
Pike Creek, Wis.:
Examination of Kenosha Harbor ..... I, 539; V, 3767
Improvement of Kenosha Harbor ..... I, 534; V, 3706
Pike, Gen. Albert, statue of (*see* Public buildings and grounds) I, 710; VIII, 5227, 5265
Pine Island Harbor, Fla. (*see* Puntarasa) ..... I, 327; III, 2041, 2043
Pine Lake, Mich. (*see* Charlevoix Harbor) ..... I, 566; V, 3928
Pine River, Mich., improvement of ..... I, 581; VI, 3989
Pine River, Minn.:
Construction of reservoir ..... I, 435; IV, 2786
Operation and care of reservoir ..... I, 437; IV, 2800
Survey of flowage lines of reservoir ..... I, 443
Pinole, Point, San Pablo Bay, Cal., examination, plan, and estimate for improvement of channel off ..... I, 634; VI, 4258, 4260
Pittsburg and Lake Erie Railroad Company, bridges of ..... I, 701
Pittsburg Harbor, Pa.:
Bridge across Allegheny River between Highland Park and Sharpsburg I, 699
Construction of Herr Island Lock and Dam, Allegheny River ..... I, 483; V, 3257
Improvement of ..... I, 481; V, 3254
Operating and care of Davis Island Dam, Ohio River ..... I, 473; V, 3140
Plaquemine Bayou, La., improvement of ..... I, 369; III, 2251
Plymouth Harbor, Mass., improvement of ..... I, 90; II, 1210
Pneumatic dynamite batteries ..... I, 10, 35
Pocomoke River, Md., improvement of ..... I, 228; II, 1658
Point Isabel, Tex. (*see* Brazos Santiago Harbor) ..... I, 397; IV, 2469
Point Judith Harbor and Pond, R. I.:
Construction of harbor of refuge ..... I, 106; II, 1269
Improvement of pond entrance ..... I, 108; II, 1271
Point Pinole, San Pablo Bay, Cal., examination, plan, and estimate for improvement of channel off ..... I, 634; VI, 4258, 4260
Point Wilson, San Pablo Bay, Cal., examination, plan, and estimate for improvement of channel off ..... I, 634; VI, 4258, 4260
Pokegama Falls, Mississippi River, Minn.:
Construction of reservoir ..... I, 435; IV, 2786
Operation and care of reservoir ..... I, 437; IV, 2800
Survey of flowage lines of reservoir ..... I, 443
Polloksville, N. C., examination of Trent River above and below ..... I, 277
Ponsett Lake, S. Dak., examination for reservoir dam ..... I, 451
Ponchatoula River, La. (*see* Tickfaw) ..... I, 362; III, 2241
Pooles Island, Chesapeake Bay, Md., removal of wreck ..... I, 284; II, 1693
Porcupine Island, Bar Harbor, Me., construction of breakwater ..... I, 47; II, 1079
Portage Lake, Manistee County, Mich., improvement of harbor of refuge ..... I, 564; V, 3922
Portage Lake and River, Houghton County, Mich., waterway via ..... I, 517, 518; V, 3598
Portage River, Ohio. *See* Port Clinton Harbor.
Port Chester Harbor, N. Y.:
Examination of ..... I, 159; II, 1422
Improvement of ..... I, 142; II, 1378
Removal of wreck off ..... I, 159; II, 1421

Port Clinton Harbor, Ohio:
Improvement of ..... I, 590; VI, 4038
Removal of wreck ..... I, 603; VI, 4096
Port Harford, Cal. (*see* San Luis Obispo Harbor) ..... I, 623; VI, 4192
Port Huron, Mich., improvement of Black River at ..... I, 580; VI, 3987
Port Jefferson Harbor, N. Y., improvement of ..... I, 148; II, 1393
Portland, Ky. *See* Falls of Ohio River.
Portland, Me.:
Defenses of ..... I, 6, 13, 734
Examination at Witch Rock, in harbor of ..... I, 64
Improvement of harbor ..... I, 60; II, 1097
Portland, Oreg.:
Examination and survey of Willamette River below ..... I, 676; VI, 4416, 4418
Harbor lines in Willamette River at ..... I, 40; VI, 4456
Improvement of Willamette River above ..... I, 667; VI, 4347
Improvement of Willamette River below ..... I, 669; VI, 4352
Port Orford Harbor, Oreg., improvement of ..... I, 634; VI, 4265
Porto Rico:
Defenses for ..... I, 6, 10, 35
Department of, reconnaissances and explorations ..... I, 718; VIII, 5449
Port Royal (Beaufort) River, S. C.:
Defenses of Port Royal Sound ..... I, 6, 10, 12, 24, 915
Improvement of ..... I, 289; III, 1873
Improvement of channel between Beaufort, S. C., and Savannah, Ga. (*see* Savannah) ..... I, 292; III, 1913
Removal of sunken logs in waterway to Charleston ..... I, 291; III, 1876
Removal of wreck of boat *Sprite* ..... I, 290; III, 1875
Port Royal Sound, S. C., defenses of ..... I, 6, 10, 12, 24, 915
Portsmouth Harbor, N. H.:
Defenses of ..... I, 6, 14, 768
Examination at Hendersons Point ..... I, 78
Examination of Pull-and-be-damned Point (Goat Island Ledge) ..... I, 77; II, 1170
Port Tampa, Fla. (*see* Tampa Bay) ..... I, 321; III, 2022
Port Washington Harbor, Wis.:
Examination of ..... I, 539; V, 3766
Improvement of ..... I, 531; V, 3692
Portwing Harbor, Wis., examination and survey ..... I, 521; V. 3630, 3633
Post of Fort Totten, N. Y ..... I, 36, 38, 1045
Potomac River:
Aqueduct Bridge, Washington, D. C., repair of ..... I, 703; VIII, 5123
Defenses of Washington, D. C ..... I, 6, 22, 876
Improvement at Washington, D. C ..... I, 284; II, 1702
Improvement below Washington, D. C ..... I, 238; II, 1706
Long Bridge, at Washington, D. C., rebuilding of ..... I, 236; II, 1702
Memorial bridge and boulevard to connect Washington, D. C., with Mount Vernon, Va ..... I, 43, 704; VIII, 5125
Removal of wreck on Mattawoman Shoal ..... I, 254; II, 1739
Powells River, Va. and Tenn., examination of ..... I, 469; V, 3067
Powow River, Mass., improvement of ..... I, 71; II, 1157
Property, personal, sale of, when not needed ..... I, 44
Providence Harbor and River, R. I.:
Examination and survey ..... I, 112; II, 1307, 1309
Improvement of ..... I, 102; II, 1257
Removal of Green Jacket Shoal ..... I, 103; II, 1260
Provincetown Harbor, Mass.:
Improvement of ..... I, 92; II, 1214
Removal of wreck ..... I, 93; II, 1219
Public buildings and grounds, District of Columbia ..... I, 710; VIII, 5227
Public structures, occupancy of, by private parties ..... I, 40; VIII, 5085
Puget Sound, Wash.:
Defenses of ..... I, 6, 12, 33, 1026
Improvement of, and tributaries ..... I, 681; VI, 4477
Improvement of waterway to lakes Union and Washington ..... I, 684; VI, 4483
Pull-and-be-damned Point, Portsmouth Harbor, N. H., examination of ..... I, 77; II, 1170
Pultneyville Harbor, N. Y.:
Improvement of ..... I, 613; VI, 4165
Removal of wreck ..... I, 619; VI, 4180
Punta Gorda, Fla. *See* Charlotte Harbor.

Puntarasa, Fla., examination and survey of inside passage to Charlotte Harbor ..... I, 327; III, 2041, 2043
Puyallup River, Wash.:
Examination of Tacoma Harbor ..... I, 693
Improvement of (*see* Puget Sound) ..... I, 681; VI, 4477

Q.

Quantico Creek, Va., examination of ..... I, 255
Queenstown Harbor, Md.:
Examination and survey ..... I, 230; II, 1673, 1675
Improvement of ..... I, 219; II, 1644
Quincy Bay, Mississippi River, Ill.:
Examination at ..... I, 434; IV, 2756
Improvement at ..... I, 432; IV, 2692
Quinnipiac River, Conn. (*see* New Haven Harbor) ..... I, 123; II, 1333

R.

Raccoon Creek, N. J., examination and survey ..... I, 207; II, 1590, 1596
Racine Harbor, Wis., improvement of ..... I, 533; V, 3702
Rainy River, Minn., bridge across ..... I, 698
Raisin River, Mich. (*see* Monroe Harbor) ..... I, 588; VI, 4019
Rancocas Creek or River, N. J.:
Bridge at Delanco ..... I, 701
Improvement of ..... I, 198; II, 1578
Range and position finders ..... I, 10, 35
Rankin, Pa., bridge across Monongahela River ..... I, 697
Rapid-fire guns ..... I, 7, 35
Rappahannock River, Va., improvement of ..... I, 243; II, 1715
Raritan Bay and River, N. J.:
Improvement of bay ..... I, 181; II, 1508
Improvement of Keyport Harbor ..... I, 183; II, 1511
Improvement of river ..... I, 179; II, 1504
Improvement of Shoal Harbor ..... I, 184; II, 1512
Removal of wreck in Keyport Harbor ..... I, 187; II, 1517
Removal of wreck near Old Orchard Shoal Light ..... I, 187; II, 1516
Rathburn, Robert H. (schooner), removal of wreck of ..... I, 359; III, 2223
Reconnaissances and explorations in military divisions and departments ..... I, 718; VIII, 5445
Red Hook Channel, New York Harbor, N. Y., improvement of ..... I, 163; II, 1464
Red Lake and Red Lake River, Minn.:
Improvement of (*see* Red River of the North) ..... I, 439; IV, 2814
Survey of ..... I, 441; IV, 2828
Red River, La., Ark., Tex., and Ind. T.:
Bridge at Alexandria, La ..... I, 698
Bridge at Grand Ecore, La ..... I, 698
Examination and survey of Alexandria Harbor ..... I, 414; IV, 2569
Examination between Kiamichi and Blue rivers ..... I, 414; IV, 2565
Examination between Shreveport, La., and Denison, Tex ..... I, 415
Gauging (*see* Mississippi River) ..... I, 412; IV, 2540
Improvement above Fulton, Ark ..... I, 401; IV, 2480
Improvement below Fulton, Ark ..... I, 398; IV, 2480
Rectification of mouth by Mississippi River Commission ..... I, 694; VII, 4525
Red River of the North, Minn. and N. Dak.:
Bridge at Drayton, N. Dak ..... I, 697
Examination of ..... I, 443; IV, 2841
Improvement of ..... I, 439; IV, 2814
Regulations governing the running of loose logs, etc., on certain streams ..... I, 43
Rhode Island, defenses of coast ..... I, 6, 12, 16, 791
Richland Creek or River, Tenn., examination of ..... I, 469; V, 3074
Richmond, Va.:
Examination and survey of James River at ..... I, 255; II, 1754, 1757
Harbor lines ..... I, 40; II, 1761
Improvement of James River up to ..... I, 251; II, 1725
Removal of wreck in James River ..... I, 254; II, 1738
Rich Passage, Puget Sound, Wash., defenses at. *See* Puget Sound.
Rioville, Nev., examination of Colorado River between El Dorado Canyon and ..... I, 624

Rivers and harbors:
Appropriations and expenditures ... I, 39, 40; VIII, 5071
Bridges ... I, 40, 43; VIII, 5103
Discontinuance of appropriations and deterioration of works ... I, 40; VIII, 5071
Dredges, hydraulic, for certain rivers ... I, 41, 315, 366, 391; III, 1985, 2246; IV, 2334
Emergency river and harbor act ... I, 39
Employees, injured, recommendation regarding aid to ... I, 44
Engineer divisions ... I, 44
Estimate of appropriation for examinations, surveys, etc ... I, 693
Estimate of appropriations for improvement of ... I, 39
Harbor lines, establishment of ... I, 40
Occupancy of public structures by private parties ... I, 40; VIII, 5085
Operating and care of canals, etc ... I, 40
Regulations governing the running of loose logs, etc., on certain streams ... I, 43
Sale of personal property when not needed, recommendation as to ... I, 44
Status of works ... I, 39
Wrecks, removal of ... I, 40
Roach, Wm. H. (schooner), removal of wreck of ... I, 229; II, 1661
Roads:
Fort Washakie, Wyo., to Buffalo Fork, Snake River ... I, 721; VIII, 5453
Washington, D. C., to Mount Vernon, Va ... I, 43
Yellowstone National Park ... I, 716; VIII, 5403
Roanoke River, N. C., improvement of ... I, 264; II, 1782
Rockhall Harbor, Md.:
Examination, plan, and estimate for improvement ... I, 230; II, 1670
Improvement of ... I, 218; II, 1643
Rockland Harbor, Me.:
Harbor lines ... I, 40; II, 1138
Improvement of ... I, 54; II, 1089
Rockport, Mass.:
Construction of harbor of refuge in Sandy Bay ... I, 72; II, 1161
Examination and survey of piers and breakwater ... I, 77; II, 1177, 1178
Resurvey and estimate of cost at breakwater, Sandy Bay, including project for completing harbor of refuge ... I, 77; II, 1184
Rock River, Ill.:
Examination of canal feeder, for lock and dam ... I, 550
Operating and care of canal around, at Milan ... I, 549; V, 3853
Rockwood, Ill., examination and survey of Mississippi River below ... I, 430; IV, 2667, 2669
Romerly Marsh, Ga., improvement of waterway via ... I, 303; III, 1953
Rondout Harbor, N. Y., improvement of ... I, 175; II, 1496
Root River, Wis. (*see* Racine Harbor) ... I, 583; V, 3702
Rouge River, Mich.:
Bridge at Dix avenue ... I, 702
Bridge at Fort street ... I, 700
Improvement of ... I, 586; VI, 4006
Rough River, Ky.:
Improvement of ... I, 511; V, 3539
Operating and care of lock and dam ... I, 512; V, 3541
Round Lake, Mich. (*see* Charlevoix Harbor) ... I, 566; V, 3928
Rouse Point, N. Y., bridge across Lake Champlain ... I, 697
Ruark, Thomas H. (sloop), removal of wreck of ... I, 254; II, 1739
Rules governing the running of loose logs, etc., on certain streams ... I, 43
Rumsey, Ky., reconstruction of Lock No. 2, Green River ... I, 509; V, 3501
Rutland-Canadian Railroad Company, bridge of ... I, 697

S.

Sabine Lake, Pass, and River, Tex.:
Defenses of ... I, 6, 12, 28, 952, 958
Examination of pass ... I, 384
Examination, plan, and estimate for improvement of channel through lake ... I, 384; III, 2302
Improvement of harbor in pass ... I, 380; III, 2276
Improvement of mouth of river ... I, 378; III, 2272
Improvement of river ... I, 379; III, 2274
Regulations governing navigation on river ... I, 43
Removal of wreck in pass ... I, 383; III, 2282

Saco River, Me., improvement of ..... I, 64; II, 1143
Sacramento County, Cal., bridge of ..... I, 699
Sacramento River, Cal.:
Bridge across Georgiana Slough at Walnut Grove ..... I, 699
Improvement by California Débris Commission ..... I, 696; VIII, 5097
Improvement from Sacramento to mouth ..... I, 629; VI, 4226
Improvement of ..... I, 628; VI, 4225
Sag Harbor, N. Y., examination, plan, and estimate for improvement ..... I, 161; II, 1451
Saginaw River, Mich., improvement of ..... I, 576; VI, 3978
St. Augustine Harbor, Fla., improvement of ..... I, 311; III, 1981
St. Charles and St. Louis County Bridge Company, bridge of ..... I, 699
St. Charles, Mo., bridge across Missouri River ..... I, 698
St. Clair River and St. Clair Flats Canal, Mich.:
Examination for doubling capacity of canal ..... I, 587
Improvement of canal ..... I, 582; VI, 3993
Improvement of channels in waters connecting Great Lakes ..... I, 569; VI, 3947
Operating and care of canal ..... I, 583; VI, 3994
St. Croix Lake and River, Wis. and Minn.:
Examination, plan, and estimate for improvement from Stillwater to Taylors Falls ..... I, 442; IV, 2836, 2839
Improvement of ..... I, 437; IV, 2809
Regulations governing navigation on ..... I, 43
St. Croix River, Me., repair of piers below Calais ..... I, 44
St. Francis River, Mo. and Ark.:
Examination from Greenville, Mo., to mouth of Mingo ..... I, 424; IV, 2618
Improvement in Arkansas ..... I, 423; IV, 2610
St. François River, Mo. *See* St. Francis River, Ark. and Mo.
St. Georges Sound, Fla., harbor lines at Dog Island ..... I, 40; III, 2158
St. Johns Plantation, St. Martin Parish, La., bridge at ..... I, 699
St. Johns River, Fla.:
Defenses of ..... I, 6, 25, 923
Improvement at Orange Mills Flats ..... I, 309; III, 1972
Improvement between Jacksonville and the ocean ..... I, 307; III, 1967
Improvement of Volusia Bar ..... I, 310; III, 1975
St. Jones River, Del.:
Examination and survey ..... I, 230; II, 1662, 1664
Improvement of (*see* Murderkill River) ..... I, 213; II, 1637
St. Joseph Harbor and River, Mich.:
Improvement of harbor ..... I, 552; V, 3879
Improvement of river ..... I, 553; V, 3883
Removal of wreck in harbor ..... I, 568; V, 3933
St. Lawrence River, N. Y.:
Cape Vincent Harbor, improvement of ..... I, 616; VI, 4173
Long Sault Island, examination at ..... I, 619
Ogdensburg Harbor, improvement of ..... I, 618; VI, 4177
Ogdensburg to Lake Ontario, removal of shoals ..... I, 617; VI, 4175
St. Louis Bay and River, Minn. and Wis. *See* Duluth Harbor.
St. Louis Harbor, Mo., improvement of ..... I, 428; IV, 2664
St. Martin Parish, La.:
Bridge across Bayou Teche at St. Johns Plantation ..... I, 699
Bridge of, across Bayou Teche at Bulliards Cove ..... I, 698
St. Marys River and St. Marys Falls Canal, Mich.:
Commercial statistics ..... I, 571, 572; VI, 3959
Improvement of channels in waters connecting Great Lakes ..... I, 569; VI, 3947
Improvement of Hay Lake Channel ..... I, 573; VI, 3969
Improvement of river at the falls ..... I, 570; VI, 3953
Operating and care of canal ..... I, 571; VI, 3956
Water levels ..... I, 715; VIII, 5402
St. Paul, Minn., gauging Mississippi River at ..... I, 441; IV, 2821
St. Peter, Minn., examination of Minnesota River at ..... I, 443; IV, 2840
St. Peter (schooner), removal of wreck of ..... I, 619; VI, 4180
Sakonnet Harbor, Point, and River, R. I.:
Examination of harbor ..... I, 112
Increasing width and depth of draw opening in Stone Bridge ..... I, 100; II, 1251
Rebuilding and extending breakwater at Sakonnet Point ..... I, 101; II, 1252
Sale of personal property when not needed ..... I, 44
Salmon Bay, Wash., improvement of waterway via ..... I, 684; VI, 4483
Salmon Creek, N. Y. *See* Pultneyville Harbor.

Sampit River, S. C.:
Examination and survey ..... I, 291; III, 1883, 1887, 1892
Improvement of Georgetown Harbor (*see also* Winyah Bay) ..... I, 280, 281; III, 1850, 1851
San Bernard River, Tex., examination and survey ..... I, 396; IV, 2438, 2440
Sandbeach, Lake Huron, Mich.:
Improvement of harbor of refuge ..... I, 578; VI, 3983
Water levels ..... I, 715; VIII, 5402
San Diego Harbor, Cal.:
Defenses of ..... I, 6, 31, 974
Improvement of ..... I, 619; VI, 4181
Sand Island, Ohio River, Ky., examination for acquisition of ..... I, 518
Sandusky Harbor, Ohio:
Examination of ..... I, 604
Improvement of ..... I, 591; VI, 4042
Removal of wreck at outer bar ..... I, 603; VI, 4094
Sandwich Harbor, Mass., examination of ..... I, 94; II, 1224
Sandy Bay, Mass.:
Construction of harbor of refuge ..... I, 72; II, 1161
Examination and survey of piers and breakwater at Rockport ..... I, 77; II, 1177, 1178
Resurvey and estimate of cost at breakwater, including project for completing harbor of refuge ..... I, 77; II, 1184
Sandy Hook, N. J., defenses at ..... I, 10, 19, 839
Sandy Lake, Minn:
Construction of reservoir ..... I, 435; IV, 2786
Operation and care of reservoir ..... I, 437; IV, 2800
San Francisco Bay and Harbor, Cal.:
Defenses of ..... I, 6, 12, 32, 980
Examination of Oakland Harbor ..... I, 634
Examination, plan, and estimate for improvement of channel between Karquines Strait and Golden Gate ..... I, 634; VI, 4258, 4260
Improvement of Oakland Harbor ..... I, 626; VI, 4218
Removal of Arch and Shag rocks ..... I, 625; VI, 4215
Sanitary District of Chicago, Ill., drainage canal ..... I, 42
San Jacinto Bay, Tex., harbor lines at Laporte ..... I, 40; IV, 2476
San Jacinto, Fort, Galveston Harbor, Tex., harbor lines at ..... I, 40; IV, 2475
San Jacinto River, Tex., improvement of waterway via ..... I, 386; IV, 2325, 2327, 2330
San Joaquin River, Cal.:
Examination above Stanislaus River ..... I, 634
Examination of channel from Antioch to Suisun Point ..... I, 634
Improvement of ..... I, 627; VI, 4223
Improvement of, by California Débris Commission ..... I, 696; VIII, 5007
San Juan, Porto Rico, defenses for ..... I, 6, 10, 35
San Leandro Bay, Cal. (*see* Oakland Harbor) ..... I, 626; VI, 4218
San Luis Obispo Harbor, Cal., improvement of ..... I, 623; VI, 4192
San Pablo Bay, Cal. (*see* Karquines Strait) ..... I, 634; VI, 4258, 4260
San Pedro Bay and Harbor, Cal.:
Construction of deep-water harbor ..... I, 621; VI, 4187
Examination and survey of inner harbor ..... I, 624; VI, 4194, 4199
Improvement of Wilmington inner harbor ..... I, 622; VI, 4191
Santee River, S. C.:
Examination and survey of waterways between North and South branches ..... I, 291; III, 1894, 1897
Improvement of ..... I, 283; III, 1856
Sarasota Bay, Fla.:
Examination and survey of inside passage to Lemon Bay ..... I, 327; III, 2054, 2060
Improvement of ..... I, 318; III, 2018
Satanella (barge), removal of wreck of ..... I, 187; II, 1516
Saugatuck, Mich., improvement of Kalamazoo River at ..... I, 555, 556; V, 3887, 3890
Saugatuck River, Conn., improvement of ..... I, 131; II, 1342
Saugerties Harbor, N. Y.:
Examination, plan, and estimate for improvement ..... I, 188; II, 1518
Improvement of ..... I, 174; II, 1494
Saugus River, Mass. *See* Lynn Harbor.
Sauk River, Wis.:
Examination of Port Washington Harbor ..... I, 539; V, 3766
Improvement of Port Washington Harbor ..... I, 531; V, 3692

Sault Ste. Marie, Mich. and Ontario:
Commerce passing canals at ..... I, 571, 572; VI, 3959
Water levels ..... I, 715; VIII, 5402
Savannah Harbor and River, Ga.:
Defenses of ..... I, 6, 25, 917
Examination of harbor ..... I, 396
Improvement of harbor, including channel to Beaufort, S. C .. I, 292; III, 1913
Improvement of river above Augusta ..... I, 296; III, 1939
Improvement of river between Augusta and Savannah ..... I, 294; III, 1928
Improvement of waterway to Fernandina, Fla ..... I, 303; III, 1953
Removal of wrecks ..... I, 306; III, 1961
Saxton, Minn., examination at ..... I, 521; V, 3629
Sayville, N. Y., improvement of Browns Creek ..... I, 157; II, 1417
Schuyler, Fort, N. Y., defenses at. *See* New York Harbor.
Schuylkill River, Pa.:
Improvement of ..... I, 193; II, 1570
Removal of wrecks ..... I, 206; II, 1588, 1589
Scituate Harbor, Mass., improvement of ..... I, 88; II, 1206
Scuppernong River, N. C., examination of bar at mouth ..... I, 277
Seabright, N. J., removal of wreck off ..... II, 1516
Seacoast defenses. *See* Fortifications.
Seal Harbor, Me., removal of wreck ..... I, 62; II, 1100
Search lights ..... I, 13, 35, 37
Sea walls ..... I, 11, 35
Sebewaing River, Mich., improvement of ..... I, 577; VI, 3981
Secretary Creek, Md. (*see* Warwick River) ..... I, 222; II, 1650
Seekonk (Pawtucket) River, R. I.:
Examinations and survey ..... I, 112; II, 1302, 1304
Improvement of ..... I, 101; II, 1254
Sewall Point Channel, Elizabeth River, Va., removal of wrecked cars in ..... I, 264; II, 1784
Shag Rocks, San Francisco Harbor, Cal., removal of ..... I, 625; VI, 4215
Sharpsburg, Pa., bridge across Allegheny River ..... I, 696
Shawneetown, Ill. (*see* Ohio River) ..... I, 469; V, 3085
Shaws Cove, New London, Conn. (*see* Thames River) ..... I, 117; II, 1325
Sheboygan Harbor, Wis., improvement of ..... I, 530; V, 3687
Sherman, General, statue of (*see* Public buildings and grounds) ..... I, 710; VIII, 5227, 5264
Shilshole Bay, Wash., improvement of waterway via ..... I, 684; VI, 4483
Ship Island Harbor and Pass, Miss.:
Improvement of channel to Gulfport ..... I, 355; III, 2216
Improvement of pass ..... I, 355; III, 2216
Ship John Light, Delaware Bay, removal of wreck of schooner *Lottie K. Friend* ..... I, 206; II, 1587
Shoal Harbor, N. J., improvement of ..... I, 184; II, 1512
Shoalwater Bay (Willapa Harbor), Wash., improvement of ..... I, 676; VI, 4463
Shreveport and Red River Valley Railway Company, bridge of ..... I, 698
Shreveport, La., waterway to Jefferson, Tex. (*see* Cypress Bayou) .. I, 401; IV, 2502
Shrewsbury River, N. J., improvement of ..... I, 185; II, 1513
Sinepuxent Bay, Md., improvement of waterway via ..... I, 217; II, 1642
Sioux City, Iowa:
Improvement of Missouri River at and above ..... I, 444; IV, 2859
Monument to Sergt. Charles Floyd near ..... I, 722; VIII, 5455
Snagging Upper Missouri River ..... I, 450; IV, 2882
Sioux River, S. Dak., examination for reservoir dam ..... I, 451
Siuslaw River, Oreg., improvement of mouth ..... I, 645; VI, 4286
Six-mile Island, Allegheny River, Pa., construction of lock and dam ..... I, 483; V, 3257
Skagit River, Wash. (*see* Puget Sound) ..... I, 681; VI, 4477
Skiddaway Narrows, Ga., examination of ..... I, 306
Slack-water systems. *See* Canals *and* Waterways.
Smallwood, Fort, Md., defenses at. *See* Baltimore Harbor.
Smyrna River, Del.:
Examination of ..... I, 231
Improvement of ..... I, 212; II, 1635
Snag boats:
For works in Florida, construction of ..... I, 315; III, 1985
For works on Texas coast; procurement of ..... I, 391; IV, 2334
Sale of, when not needed ..... I, 44

Snake River, Alaska, bridge across ..... I, 698
Snake River, Wash., Oreg., and Idaho:
Examination from Asotin, Wash., to Pittsburg Landing, Oreg ..... I, 665; VI, 4338
Examination from mouth to head of navigation ..... I, 666
Improvement up to Asotin, Wash ..... I, 652; VI, 4319
Road from Buffalo Fork to Fort Washakie, Wyo ..... I, 721; VIII, 5453
Snohomish River, Wash.:
Improvement of (*see* Puget Sound) ..... I, 681; VI, 4477
Improvement of Everett Harbor ..... I, 686; VI, 4485
Snoqualmie River, Wash.:
Bridge at Novelty ..... I, 699
Bridge near Tolt ..... I, 700
Improvement of (*see* Puget Sound) ..... I, 681; VI, 4477
Sodo Lakes, La. (*see* Cypress Bayou) ..... I, 401; IV, 2502
Sonoma Creek, Cal., examination of ..... I, 633; VI, 4256
South Atlantic States, removal of water hyacinth ..... I, 315; III, 1985
South Branch, Chicago River, Ill. *See* Chicago Harbor and River.
South Branch, Santee River, S. C. *See* Santee River.
South Carolina, defenses of coast of ..... I, 6, 10, 12, 24, 911
South Chicago, Ill.:
Bridge across Calumet River ..... I, 699
Improvement of (*see* Calumet Harbor) ..... I, 542; V, 3788
Southern Branch, Elizabeth River, Va.:
Improvement of Norfolk Harbor and approaches ..... I, 255; II, 1763
Improvement of waterway to Albemarle Sound, N. C., via Currituck Sound ..... I, 262; II, 1778
Improvement of waterway to sounds of North Carolina, via Pasquotank River ..... I, 261; II, 1773
Removal of wreck ..... I, 264; II, 1783
Southern Railway Company, examination of Norfolk Harbor, Va., at vicinity of pier of ..... I, 265
South Haven Harbor, Mich., improvement of ..... I, 554; V, 3884
South Hero Island Channel, Lake Champlain, Vt., improvement of ..... I, 167
South Mills, N. C.:
Examination of waterway to and including Beaufort and Ocracoke inlets ..... I, 265, 277
Improvement of waterway from Norfolk, Va., to sounds of North Carolina ..... I, 261; II, 1773
South Milwaukee Harbor, Wis., improvement of ..... I, 533; V, 3701
South Norwalk Harbor, Conn. (*see* Norwalk) ..... I, 133; II, 1344
South Pass, Mississippi River, improvement of ..... I, 41, 360, 366; III, 2225
South River, N. J., improvement of ..... I, 180; II, 1506
South San Francisco Harbor, Cal., examination of ..... I, 633; VI, 4248
South Sioux City, Iowa (*see* Missouri River) ..... I, 444; IV, 2859
Southwest Pass, Mississippi River, plans and estimates for improvement ..... I, 365, 366, 383; III, 2287
Springdale, Pa., construction of lock and dam in Allegheny River ..... I, 483; V, 3257
Spring Garden, Baltimore, Md., improvement at ..... I, 233; II, 1693
Springwells Township, Mich.:
Bridge of, across Rouge River at Dix avenue ..... I, 702
Bridge of, across Rouge River at Fort street ..... I, 700
Sprite (boat), removal of wreck of ..... I, 290; III, 1875
Spuyten Duyvill Creek, N. Y. (*see* Harlem River) ..... I, 153; II, 1406
Squan (Manasquan) River, N. J., improvement of ..... I, 186; II, 1514
Stage Harbor, Mass. (*see* Chatham) ..... I, 92; II, 1217
Stamford Harbor, Conn.:
Harbor lines ..... I, 40; II, 1368
Improvement of ..... I, 187; II, 1347
Stanbery, Henry (schooner), removal of wreck of ..... I, 826; III, 2032
Staten Island, N. Y.:
Defenses on. *See* New York Harbor.
Examination and survey of channel between New Jersey and (*see* Arthur Kill) ..... I, 188; II, 1525, 1527
Improvement of channel between New Jersey and ..... I, 178; II, 1502
Staten Island Sound, N. Y. and N. J. *See* Arthur Kill.
Statistics, commercial, of canals at Sault Ste. Marie, Mich. and Ontario ..... I, 571, 572; VI, 3959

Steamboats:
See also Dredge *and* Snag boats *and* Wrecks.
Regulations governing running of, on certain streams ..... I, 43
Stilaguamish River, Wash. (*see* Puget Sound) ..... I, 681; VI, 4477
Stillwater Harbor, Minn.:
Examination, plan, and estimate for improvement of St. Croix River to Taylors Falls ..... I, 442; IV, 2836, 2839
Improvement of St. Croix River at ..... I, 437; IV, 2809
Stonington, Conn., construction of harbor of refuge ..... I, 114; II, 1322
Stony Lake, Mich., examination of channel to Lake Michigan ..... I, 569; V, 3939
Structures, public, occupancy of, by private parties ..... I, 40; VIII, 5085
Sturgeon Bay and Lake Michigan Canal, Wis.:
Construction of harbor of refuge ..... I, 526; V, 3672
Examination of ..... I, 539
Improvement of ..... I, 525; V, 3659
Operating and care ..... I, 526; V, 3666
Sturgeon Bay Bridge Company, bridge of ..... I, 702
Sturgeon Bay., Wis., bridge obstructing ..... I, 702
Submarine mines ..... I, 5, 12, 35, 37
Suck, the, Tennessee River:
Improvement of (*see* Tennessee River, below Chattanooga) ..... I, 460; V, 2912
Survey at ..... I, 468; V, 2956
Suisun Bay, Cal., examination from Suisun Point to San Joaquin River ..... I, 634
Suisun Creek, Cal., examination of ..... I, 633; VI, 4250
Sullivan Falls Harbor, Me., improvement of ..... I, 48; II, 1080
Sullivan Island, Charleston Harbor, S. C.:
Bridge across Breach Inlet ..... I, 700
Improvement at ..... I, 287; III, 1867
Sullivan River, Me., improvement of Sullivan Falls Harbor ..... I, 48; II, 1080
Sunken vessels. *See* Wrecks.
Superior Bay and Harbor, Wis.:
Harbor lines ..... I, 40; V, 3642
Improvement of ..... I, 514; V, 3554
Superior Lake:
See also Northern and Northwestern Lakes.
Improvement and operating and care of waterway to Keweenaw Bay ..... I, 517, 518; V, 3598
Survey for canal to Mississippi River ..... I, 521; V, 3613
Water levels ..... I, 715; VIII, 5319, 5402
Supervision of the harbor of New York, N. Y ..... I, 693; VI, 4513
Surveys:
Estimate of appropriation for ..... I, 693
In military divisions and departments ..... I, 718, 721; VIII, 5445
Northern and Northwestern Lakes ..... I, 711; VIII, 5317
Susquehanna River, Md.:
Examination of Havre de Grace Harbor ..... I, 231
Improvement above and below Havre de Grace ..... I, 218; II, 1642
Suwanee River, Fla., improvement of ..... I, 325; III, 2030
Swan Lake, Miss., bridge across Tallahatchie River ..... I, 698
Swash Channel, New York Harbor, N. Y., removal of wreck ..... I, 167; II, 1474
Swinomish Slough, Wash., improvement of ..... I, 687; VI, 4487
Sylvia de Grasse (steamer), wreck of (*see* Columbia River, below Tongue Point) ..... I, 670; VI, 4360
Synepuxent Bay, Md., improvement of waterway via ..... I, 217; II, 1642

T.

Tacoma Harbor, Wash., examination of ..... I, 693
Tail of the Horseshoe, Chesapeake Bay, removal of wreck on ..... I, 264; II, 1783
Tallahatchie County, Miss., bridge of ..... I, 698
Tallahatchie River, Miss.:
Bridge across ..... I, 698
Improvement of ..... I, 410; IV, 2534
Tampa Bay and City, Fla.:
Defenses of ..... I, 6, 26, 929
Harbor lines in Hillsboro River at Tampa ..... I, 40; III, 2084
Improvement of bay ..... I, 321; III, 2023
Improvement of Hillsboro Bay and River ..... I, 323; III, 2025
Removal of wreck in bay ..... I, 326; III, 2032

Tangier Island and Sound, Md. and Va.:
Examination for channel to Tangier Island ... I, 231; II, 1684
Removal of wreck at Deals Island ... I, 229; II, 1661
Tanners Creek, Va., bridge near Norfolk ... I, 700
Tarpaulin Cove, Mass., removal of wreck ... I, 110; II, 1281
Tar River, N. C., improvement of ... I, 267; III, 1798
Tarrytown Harbor, N. Y., examination and survey ... I, 188; II, 1520, 1522
Taunton River, Mass:
Improvement of ... I, 99; II, 1248
Improvement of Fall River Harbor ... I, 104; II, 1263
Tchefuncte (Chefuncte) River, La., improvement of ... I, 361; III, 2240
Teche Bayou, La.:
Bridge at Bulliards Cove ... I, 698
Bridge at St. Johns Plantation, St. Martin Parish ... I, 699
Improvement of ... I, 372; III, 2260
Telegraph line connecting Executive Departments, Washington, D. C. (*see* Public buildings and grounds) ... I, 710; VIII, 5227, 5262
Tennessee River:
Bridgeport to Decatur, Ala., survey from ... I, 468; V, 3308
Bridges across, report on Congressional bill providing for construction of ... I, 40; VIII, 5103
Chattanooga, Tenn., to Riverton, Ala., survey from ... I, 469
Chattanooga, Tenn., improvement above ... I, 458; V, 2908
Chattanooga, Tenn., to Decatur, Ala., improvement from ... I, 460; V, 2912
Decatur to Florence, Ala., improvement from ... I, 460; V, 2914
Florence to foot of Bee Tree Shoals, Ala., improvement from ... I, 460; V, 2914
Gauging (*see* Mississippi River) ... I, 412; IV, 2540
Moccasin Bend, Tenn., examination for canal ... I, 468; V, 3005
Muscle Shoals Canal, Ala., operating and care ... I, 463; V, 2934
Paducah, Ky., survey at ... I, 477; V, 3219
River system ... I, 458; V, 2907
Riverton, Ala., improvement below ... I, 460; V, 2916
Suck, or mountain section below Chattanooga, Tenn., survey at ... I, 468; V, 2956
Tensas River, Ala., bridge near Mobile ... I, 699
Tensas River, La., improvement of ... I, 406; IV, 2517
Terraceia Cut-off, Fla. (*see* Manatee River) ... I, 319; III, 2020
Texas City, Tex., deepening channel to Galveston Harbor ... I, 386; IV, 2326
Texas, procurement of dredge and snag boat for works on coast of ... I, 391; IV, 2334
Thames River, Conn.:
Harbor lines at New London Harbor ... I, 40; II, 1363
Improvement of, including New London Harbor ... I, 117; II, 1325
Survey of New London Harbor ... I, 141; II, 1351
The Board of Engineers ... I, 5, 6, 727
Three-mile Creek, Ala., bridge near Mobile ... I, 700
Three-mile Harbor, Long Island, N. Y., examination of ... I, 161; II, 1454
Three-mile Rapids, Columbia River, Oreg. and Wash., improvement at ... I, 655; VI, 4322
Three-mile Riffle (Ripple), Licking River, Ky., survey for lock and dam ... I, 476; V, 3155
Thunder Bay River, Mich., improvement of Alpena Harbor ... I, 575; VI, 3975
Tickfaw River, La., improvement of, including tributaries ... I, 362; III, 2241
Tillamook Bay and Bar, Oreg., improvement of ... I, 650; VI, 4314
Tiverton, R. I., alteration of Stone Bridge across Sakonnet River ... I, 100; II, 1251
Toledo Harbor, Ohio:
Bridge across Maumee River ... I, 699
Improvement of ... I, 589; VI, 4022
Removal of wreck near outer entrance to Maumee Bay ... I, 603; VI, 4095
Tolomato River, Fla. (*see* St. Augustine Harbor) ... I, 311; III, 1981
Tolt, Wash., bridge across Snoqualmie River ... I, 700
Tombigbee River, Ala. and Miss.:
Columbus to Fulton, Miss., improvement from ... I, 349; III, 2206
Demopolis, Ala., below, improvement ... I, 347; III, 2202
Demopolis, Ala., to Columbus, Miss., improvement from ... I, 349; III, 2205
Examination for locks and dams on Warrior River ... I, 360
Fulton to Walkers Bridge, Miss., improvement from ... I, 350; III, 2207
Tonawanda Creek and Harbor, N. Y.:
Examination and survey ... I, 611; VI, 4152, 4155
Harbor lines at North Tonawanda ... I, 40; VI, 4159
Improvement of harbor ... I, 609; VI, 4138

Tongue Point, Columbia River, Oreg., improvement below ..... I, 670; VI, 4360
Tonnag through canals at Sault Ste. Marie, Mich. and Ontario. I, 571, 572; VI, 3959
Torpedoes ..... I, 5, 12, 35, 37, 731, 1064
Totten, Fort, N. Y., post of ..... I, 36, 38, 1045
Town Creek, Brunswick County, N. C., improvement of ..... I, 275; III, 1827
Town River, Mass., improvement of ..... I, 85; II, 1203
Trail Creek, Ind. *See* Michigan City Harbor.
Traverse Lake, Minn., survey of ..... I, 442; IV, 2833
Trenton, N. C., examination of Trent River up to ..... I, 277
Trent River, N. C.:
  Examination of ..... I, 277
  Harbor lines at Newbern ..... I, 40; III, 1837
  Improvement of ..... I, 268; III, 1802
Trinity River, Tex.:
  Examination from Dallas to city of Fort Worth ..... I, 396
  Improvement of ..... I, 388; IV, 2329
  Survey from mouth to Dallas ..... I, 394; IV, 2348
Troops, engineer, equipment of ..... I, 35, 38
Tuckerton Creek, N. J., examination and survey ..... I, 207; II, 1612, 1614
Tugboats, sale of, when not needed ..... I, 44
Tug Fork, Big Sandy River, W. Va. and Ky.:
  Improvement of ..... I, 498; V, 3357
  Survey of ..... I, 503; V, 3400
Turners Cut, N. C.:
  Examination of waterway from South Mills to and including Beaufort and Ocracoke inlets ..... I, 265, 277
  Improvement of waterway via ..... I, 261; II, 1773
Turrets ..... I, 7
Turtle Bayou, Tex., examination and survey ..... I, 394; IV, 2342, 2345
Turtle River, Ga. *See* Brunswick Harbor.
Tuttle, Horace A. (steamer), removal of wreck of ..... I, 568; V, 3933
Twelve-mile Creek, Fla. (*see* Orange River) ..... I, 326; III, 2032, 2035
Twelve-mile Creek, N. Y. (*see* Wilson Harbor) ..... I, 612; VI, 4161
Twin Rivers, Wis.:
  Examination of Two Rivers Harbor ..... I, 538; V, 3759
  Improvement of Two Rivers Harbor ..... I, 528; V, 3681
Two Harbors, Minn.:
  Examination of Burlington Bay ..... I, 522
  Improvement of Agate Bay ..... I, 513; V, 3551
Two Islands, Minn., examination at ..... I, 521; V, 3629
Two Rivers Harbor, Wis.:
  Examination of ..... I, 538; V, 3759
  Improvement of ..... I, 528; V, 3681
Tyaskin (Wetipquin) Creek, Md. examination and survey ..... I, 231; II, 1681, 1683

U.

Union Lake, Wash., improvement of waterway via ..... I, 684; VI, 4483
Union Railroad Company, bridge of ..... I, 697
Union River, Me., improvement of ..... I, 49; II, 1081
United States Engineer School, Fort Totten, N. Y ..... I, 36, 38, 1047
Upper New York Bay, N. Y. *See* New York Harbor.
Urbana Creek, Va., improvement of ..... I, 245; II, 1717
Use of public structures by private parties ..... I, 40; VIII, 5085

V.

Van Cleaf, G. W. (schooner), removal of wreck of ..... I, 187; II, 1517
Vermilion Bayou, La., improvement of channel, bay, and passes ..... I, 373; III, 2262
Vessels. *See* Dredge *and* Snag boats, Steamboats, *and* Wrecks.
Vicksburg Harbor, Miss., improvement of ..... I, 408; IV, 2524
Vicksburg (schooner), removal of wreck of ..... I, 62; II, 1100
Victory (canal boat), removal of wreck of ..... I, 206; II, 1589
Vidalia Harbor, La. (*see* Mississippi River Commission) ..... I, 694; VII, 4525
Vinalhaven, Me., improvement of Carvers Harbor ..... I, 56; II, 1092
Vineyard Haven, Mass.:
  Examination for harbor of refuge ..... I, 111; II, 1289
  Improvement of harbor at ..... I, 96; II, 1240
  Removal of wrecks ..... I, 110; II, 1281
Vineyard Sound, Mass., removal of wreck in Tarpaulin Cove ..... I, 110; II, 1281
Volusia Bar, St. Johns River, Fla., improvement of ..... I, 310; III, 1978

W.

Wabash River, Ind. and Ill.:
Improvement above Vincennes, Ind ... I, 508; V, 3497
Improvement below Vincennes, Ind ... I, 507; V, 3497
Operating and care of Grand Rapids Lock and Dam ... I, 508; V, 3498
Waccamaw River, N. C. and S. C., improvement of ... I, 277; III, 1841
Wadsworth, Fort, N. Y., defenses at. *See* New York Harbor.
Wagners Landing, Mississippi River, Ill., examination and survey ... I, 430; IV, 2667, 2669
Wahkiakum County, Wash., bridge of ... I, 699
Wakefield, Va., monument and wharf at Bridge Creek Landing ... I, 711; VIII, 5227, 5266
Walden Slough, San Joaquin River, Cal., examination for closure of ... I, 634
Wallabout Channel, N. Y., improvement of ... I, 156; II, 1413
Walls, sea ... I, 11, 35
Walnut Grove, Cal., bridge across Georgiana Slough, Sacramento River ... I, 699
Wappoo Cut, S. C., improvement of ... I, 289; III, 1872
War maps ... I, 718, 721; VIII, 5445
Warrior River, Ala.:
Examination for Locks and Dams Nos. 1, 2, and 3 ... I, 360
Improvement above Tuscaloosa ... I, 346; III, 2167
Improvement below Tuscaloosa ... I, 346; III, 2177
Operating and care of locks and dams above Tuscaloosa ... I, 346; III, 2171
Warroad Harbor and River, Minn.:
Examination of ... I, 443
Improvement of bar at mouth of river ... I, 440; IV, 2820
Warwick River, Md., improvement of ... I, 222; II, 1650
Washakie, Fort, Wyo., road to Buffalo Fork, Snake River ... I, 721; VIII, 5453
Washington, D. C.:
Aqueduct Bridge, repair of ... I, 703; VIII, 5123
Aqueduct, filtration plant ... I, 709; VIII, 5224
Aqueduct, increasing water supply ... I, 707; VIII, 5208
Aqueduct, investigating water supply ... I, 709; VIII, 5224
Aqueduct, maintenance and repair ... I, 705; VIII, 5193
Aqueduct Tunnel and Howard University Reservoir ... I, 707; VIII, 5208
Defenses of ... I, 6, 22, 876
Improvement of Potomac River at ... I, 234; II, 1702
Improvement of Potomac River below ... I, 238; II, 1706
Long Bridge, across Potomac River, rebuilding of ... I, 236; II, 1702
Memorial bridge and boulevard to connect with Mount Vernon, Va ... I, 43, 704; VIII, 5125
Public buildings and grounds and Washington Monument ... I, 710; VIII, 5227
Washington, George:
Memorial bridge and boulevard to connect Washington, D. C., with tomb of, at Mount Vernon, Va ... I, 43, 704; VIII, 5125
Monument to, at Wakefield, Va ... I, 711; VIII, 5227, 5266
Monument to, at Washington, D. C ... I, 710; VIII, 5227, 5233
Washington Lake, Wash., improvement of waterway to Puget Sound ... I, 684; VI, 4483
Washita River, Ark. and La. *See* Ouachita.
Wateree River, S. C., improvement of ... I, 284; III, 1860
Water hyacinth:
Removal of, from Florida waters ... I, 315; III, 1985
Removal of, from Louisiana waters ... I, 377; III, 2270
Water-level observations:
Columbia River, Oreg. and Wash ... I, 675; VI, 4368
Mississippi River and tributaries ... I, 412; IV, 2540
Mississippi River at St. Paul, Minn ... I, 441; IV, 2821
Northern and Northwestern Lakes ... I, 715; VIII, 5319, 5402
Waters, navigable. *See* Bridges, Rivers and harbors, *and* Wrecks.
Waterways (*see also* Canals):
Beaufort, N. C., to Newbern ... I, 270; III, 1806
Beaufort, N. C., to New River ... I, 271; III, 1810
Charleston to Beaufort, S. C., sunken logs ... I, 291; III, 1876
Charleston Harbor, S. C., to Alligator Creek or River ... I, 292; III, 1908
Chincoteague Bay, Va., to Delaware Bay, Del ... I, 217; II, 1642
Estherville-Minim Creek Canal, S. C., to Alligator Creek or River ... I, 291; III, 1894, 1897
Galveston to Houston, Tex ... I, 386; IV, 2325, 2327, 2330

Waterways—Continued.
Illinois and Des Plaines rivers, Ill., to Lake Michigan ... I, 549; V, 3855
Keweenaw Bay to Lake Superior, Mich ... I, 517, 518; V, 3596
Kissimmee River, Fla., to Gulf of Mexico ... I, 327
Norfolk, Va., to Albemarle Sound, N. C., via Currituck Sound ... I, 262; II, 1778
Norfolk, Va., to sounds of North Carolina, via Pasquotank River ... I, 261; II, 1773
Puget Sound to lakes Union and Washington ... I, 684; VI, 4483
Puntarasa, Fla., to Charlotte Harbor ... I, 327; III, 2041, 2043
Sarasota Bay, Fla., to Lemon Bay ... I, 327; III, 2054, 2060
Savannah, Ga., to Beaufort, S. C ... I, 292; III, 1913
Savannah, Ga., to Fernandina, Fla ... I, 303; III, 1953
Shreveport, La., to Jefferson, Tex. (*see* Cypress Bayou) ... I, 401; IV, 2562
South Mills, N. C., to and including Beaufort and Ocracoke inlets ... I, 265, 277
Superior Lake to Mississippi River ... I, 521; V, 3613
Watson, Katie (canal boat), removal of wreck of ... I, 187; II, 1516
Waukegan Harbor, Ill.:
Examination and survey ... I, 539; V, 3769, 3772
Improvement of ... I, 535; V, 3769
Weetee Lake, S. C., examination and survey ... I, 291; III, 1903, 1905
West Boston Bridge, across Charles River, Mass., to Cambridge ... I, 697
Westchester Creek, N. Y., examination, plan, and estimate for improvement ... I, 160; II, 1430, 1433
Western Branch, Elizabeth River, Va., improvement of ... I, 256; II, 1765
West Fork River, W. Va., survey of ... I, 486; V, 3267
West Galveston Bay, Tex., improvement of channel and mouths of adjacent streams ... I, 389, 391; IV, 2331, 2334
Westport Harbor, Conn., improvement of ... I, 131; II, 1342
Westport Harbor, Mass. (*see* Westport Point) ... I, 111; II, 1298
Westport Point Harbor, Mass., examination of ... I, 111; II, 1298
West River, New Haven, Conn., bridge across, at Kimberly avenue ... I, 702
Wetipquin Creek, Md., examination and survey ... I, 231; II, 1681, 1683
Weymouth River, Mass., improvement of ... I, 86; II, 1204
Wharves, public, occupancy of, by private parties ... I, 40; VIII, 5085
White Lake Harbor, Mich., improvement of ... I, 560; V, 3909
White River, Ark.:
Gauging (*see* Mississippi River) ... I, 412; IV, 2540
Improvement by open-channel work ... I, 418; IV, 2592
Improvement of Buffalo Fork ... I, 420; IV, 2601
Improvement of upper river by locks and dams ... I, 419; IV, 2596
White River, Ind., improvement of ... I, 509; V, 3500
Whitney, W. M. (steamboat), removal of wreck of ... I, 187; II, 1516
Wickford Harbor, R. I., improvement of ... I, 104; II, 1261
Wicomico River, eastern shore of Maryland, improvement of ... I, 226; II, 1655
Willamette Falls and River, Oreg.:
Examination and survey for acquisition of canal and locks at the falls ... I, 675; VI, 4368, 4374
Examination and survey of river below Portland ... I, 676; VI, 4416, 4418
Harbor lines in river at Portland ... I, 40; VI, 4456
Improvement of river above Portland ... I, 667; VI, 4347
Improvement of river below Portland ... I, 669; VI, 4352
Willapa River and Harbor, Wash., improvement of ... I, 676; VI, 4463
Willard, E. C. (schooner), removal of wreck of ... I, 110; II, 1281
Willets Point, N. Y.:
Battalion of Engineers ... I, 36, 1050
Engineer Depot ... I, 37, 1052
Engineer School ... I, 36, 1047
Fort Totten, post of ... I, 36, 1045
Williams, Castle, Governors Island, N. Y., removal of wreck below ... I, 166; II, 1473
Wilmington, Cal.:
Construction of deep-water harbor in San Pedro Bay ... I, 621; VI, 4187
Examination and survey of San Pedro inner harbor ... I, 624; VI, 4194, 4199
Improvement of inner harbor ... I, 622; VI, 4191
Wilmington, Del., improvement of harbor ... I, 208; II, 1636
Wilmington, N. C.:
Defenses of ... I, 6, 11, 12, 23, 897
Examination of Cape Fear River at and above ... I, 277
Improvement of Cape Fear River above ... I, 274; III, 1816
Improvement of Cape Fear River at and below ... I, 274; III, 1818
Wilson Harbor, N. Y., improvement of ... I, 612; VI, 4161

Wilson, Point, San Pablo Bay, Cal., examination, plan, and estimate for improvement of channel off ..... I, 634; VI, 4258, 4260
Winnebago Lake, Wis. (*see* Fox River) ..... I, 536; V, 3712
Winnibigoshish Lake, Minn.:
Construction of reservoir ..... I, 435; IV, 2786
Operation and care of reservoir ..... I, 437; IV, 2800
Survey of flowage lines of reservoir ..... I, 443
Winthrop Harbor, Mass., examination of ..... I, 93; II, 1219
Winyah Bay, S. C., improvement of ..... I, 281; III, 1851
Wisconsin Entrance, Wis. (*see* Duluth Harbor) ..... I, 514; V, 3554
Witch Rock, Portland Harbor, Me., examination at ..... I, 64
Withlacoochee River, Fla., improvement of ..... I, 324; III, 2029
Wolf River, Tenn. *See* Memphis Harbor.
Wolf (Ahnapee) River, Wis. (*see* Ahnapee Harbor) ..... I, 527; V, 3674
Woodbridge Creek, N. J., examination and survey ..... I, 188; II, 1552, 1554
Woods Hole Channel, Mass., improvement of ..... I, 97; II, 1242
Wrecks, etc., removal of ..... I, 40
Baltimore Harbor (Patapsco River), Md ..... I, 234; II, 1693
Barnegat Light, N. J., off ..... II, 1588
Bath, Me ..... I, 62; II, 1100
Beaufort River, S. C. (boat *Sprite*) ..... I, 290; III, 1875
Beaufort to Charleston, S. C., inland passage ..... I, 291; III, 1876
Billingsport, N. J., below ..... I, 206; II, 1589
Black River, Ark ..... I, 424; IV, 2613
Cambridge Harbor, Md ..... I, 229; II, 1660
Charleston to Beaufort, S. C., inland passage ..... I, 291; III, 1876
Chatham New Harbor, Mass ..... I, 93; II, 1218
Chesapeake Bay ..... I, 234, 264; II, 1693, 1783
Chester Creek, Pa ..... I, 206; II, 1589
Choptank River (Cambridge Harbor), Md ..... I, 229; II, 1660
Cleveland Harbor, Ohio ..... I, 603; VI, 4096
Columbia River, Oreg., below Tongue Point ..... I, 670; VI, 4360
Deals Island, Md ..... I, 229; II, 1661
Delaware Bay and River ..... I, 206; II, 1587
Dennis Creek, N. J ..... I, 206; II, 1589
East River, N. Y ..... II, 1422
Elgin, Ark ..... I, 424; IV, 2613
Elizabeth River, Va ..... I, 264; II, 1783, 1784
Erie Lake ..... I, 603; VI, 4094, 4095, 4096
Flynns Knoll, near entrance to New York Harbor, N. Y ..... I, 166; II, 1472
Frankfort, Me ..... I, 62; II, 1100
Galveston Harbor, Tex ..... I, 394; IV, 2341
Hampton Creek, Va ..... I, 264; II, 1784
Harlem River, N. Y ..... I, 159; II, 1421
Hudson River, N. Y ..... I, 187; II, 1516, 1517
Hudson, N. Y ..... I, 187; II, 1516
James River, Va ..... I, 254; II, 1738
Judsonia, Ark ..... I, 424; IV, 2613
Kennebec River, Me ..... I, 62; II, 1100
Keyport Harbor, N. J ..... I, 187; II, 1517
Little Creek, Del ..... I, 229; II, 1660
Little Red River, Ark ..... I, 424; IV, 2613
Long Island Sound, off Port Chester, N. Y ..... I, 159; II, 1421
Lynn Harbor, Mass ..... I, 77; II, 1169
Manokin River, Md ..... I, 229; II, 1661
Marsh River, Me ..... I, 62; II, 1100
Mattawoman Shoal, Potomac River ..... I, 254; II, 1739
Maumee Bay, Ohio ..... I, 603; VI, 4095
Maurice River, N. J ..... I, 206; II, 1589
Michigan City Harbor, Ind ..... I, 568; V, 3933
Mississippi River, above Missouri River ..... I, 431; IV, 2679
Mississippi River, below Missouri River ..... I, 425; IV, 2621
Mobile River, Ala., at Mobile ..... I, 359; III, 2223
Mott Haven, New York, N. Y ..... I, 159; II, 1421
Newark Bay, N. J ..... I, 187; II, 1516
New Baltimore, N. Y ..... I, 187; II, 1516
New York Harbor, N. Y. (*See* New York Harbor.)
Norfolk Harbor, Va ..... I, 264; II, 1783, 1784

Wrecks, etc., removal of—Continued.
Ohio River ..... I, 472; V, 3129
Pascagoula Harbor, Miss ..... I, 359; III, 2223
Patapsco River, Md ..... I, 234; II, 1683
Philadelphia, Pa ..... I, 206; II, 1588, 1589
Pooles Island, Chesapeake Bay, Md ..... I, 234; II, 1683
Port Chester Harbor, N. Y ..... I, 159; II, 1421
Port Clinton Harbor, Ohio ..... I, 603; VI, 4096
Port Royal (Beaufort) River, S. C. (boat *Sprite*) ..... I, 290; III, 1877
Potomac River ..... I, 254; II, 1739
Provincetown Harbor, Mass ..... I, 93; II, 1219
Pultneyville Harbor, N. Y ..... I, 619; VI, 4189
Raritan Bay, N. J ..... I, 187; II, 1516, 1517
Richmond, Va ..... I, 254; II, 1738
Sabine Pass, Tex ..... I, 383; III, 2282
St. Joseph Harbor, Mich ..... I, 568; V, 3933
Sandusky Harbor, Ohio ..... I, 603; VI, 4094
Savannah Harbor and River, Ga ..... I, 306; III, 1961
Schuylkill River, Pa ..... I, 206; II, 1588, 1589
Seabright, N. J ..... II, 1516
Seal Harbor, Me ..... I, 62; II, 1100
Southern Branch, Elizabeth River, Va ..... I, 264; II, 1783
Tampa Bay, Fla ..... I, 326; III, 2032
Tangier Sound, at Deals Island, Md ..... I, 229; II, 1661
Tarpaulin Cove, Mass ..... I, 110; II, 1281
Toledo Harbor (Maumee Bay), Ohio ..... I, 603; VI, 4095
Vineyard Haven Harbor and Sound, Mass ..... I, 110; II, 1281
Yankee Point, Schuylkill River, Pa ..... I, 206; II, 1589

Y.

Yamhill River, Oreg., improvement of ..... I, 667; VI, 4347
Yankee Point, Schuylkill River, Pa., removal of wreck ..... I, 206; II, 1589
Yankton, S. Dak. (*see* Missouri River) ..... I, 444; IV, 2859
Yaquina Bay, Oreg.:
Examination of ..... I, 649; VI, 4293
Improvement of ..... I, 646; VI, 4291
Yazoo River, Miss.:
Improvement above mouth ..... I, 407; IV, 2519
Improvement of mouth, including Vicksburg Harbor ..... I, 408; IV, 2524
Yellowstone National Park, improvement of ..... I, 716; VIII, 5403
Yellowstone River, Mont. and N. Dak., improvement of ..... I, 450
York River, Va., improvement of ..... I, 247; II, 1721
Youghiogheny River, Pa., examination, plan, and estimate for improvement ..... I, 486; V, 3283
Yuba River, Cal. (*see* Sacramento River *and* California Débris Commission) ..... I, 628, 696; VI, 4227; VIII, 5007

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